The propose paper identify the efficient and significant role of CC its security issues. Application domains are-
Home networking: Smart appliances, home security, electronics & telecommunication, smart floors, smart buildings.
Automotive: Diagnostics, Biomedical[3] & telemetry, occupant safety, ,collision avoidance.
Industrial automation: Factory automation, hazardous material control.
Traffic management: Flow monitoring, collision avoidance
Security: Building/office security, equipment tagging, homeland security.
Environmental monitoring: Habitat monitoring, seismic activity, local/global environmental trends, agricultural
Defence and Satellite applications.Refer Fig.2.

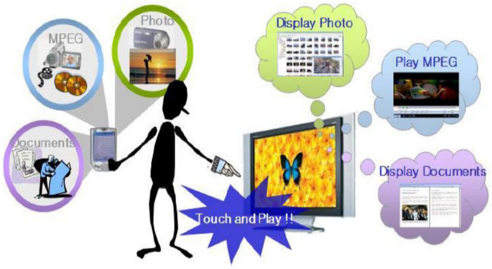


Fig. 2. Applications of Cooperative communication networks.

II COOPERATIVE COMMUNICATION

Wireless Body Area Cooperative communication(CC) network used in various application has following basic elements:

1) *Applications & Services*
2) *Cooperative Communications:* Consists of Features of CC, Cooperation Mechanisms & CC in WBANs
3) *Network Architecture of WBANs:WBANs* provide short range, low power and highly reliable wireless communication for use in close proximity to or inside body. Data rate up to 10Mbps,Range: 2m to 5m.
4) *MAC and Route Protocols*
5) *Interworking and Security*

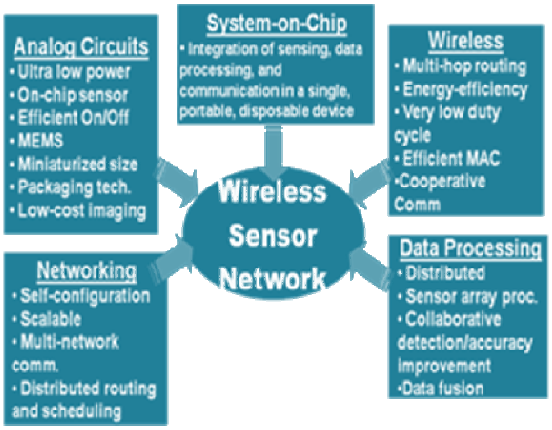


Fig. 3.1. Wireless Sensor & CC network Thrust areas.

CC provide an alternative form of spatial diversity. The concept of cooperative communications is to exploit the broadcast nature of the wireless medium by transforming single-antenna terminals into a virtual antenna array. Thus, multiple signals are transmitted from source and relay(s) terminals through Advanced[10][11] Applications using Cooperative Wireless Networks uncorrelated channels to the destination and provide benefits of spatial diversity.

When studying spatial diversity in wireless communications, it is useful to consider the space separation over which a wireless channel is considered stationary. This space separation is referred to as the coherence distance Dc. A transmission technique is achieving space diversity when it enables the emission and/or reception of signal components separated by a distance of Dc at least. In the following, we present a transmission scheme[6][8] achieving spatial diversity. When a source terminal S transmits a signal to a destination terminal D through its direct path (S-D), other terminals such as the relay terminal R can overhear the signal. So when terminal R is in a cooperative mode, it forwards the source message to the destination D. Thus, D receives two signals: the original one transmitted from S through the direct path (S-D) and the relayed one forwarded by R through the relayed path (S-R-D). As a result, the two received signals at the destination terminal are combined to achieve a better spatial diversity compared to the one achieved with a single direct path. Note that more than one relay terminal can be deployed. Moreover, in this thesis, S and D can also represent a current terminal and next hop terminal in multi-hop networks.as shown in Fig. 4.
In multi-hop networks the cooperation can be used in any intermediate hop along the data transmission route. A relay terminal or a set of relay terminals helps on data relaying from a previous terminal to a next-hop terminal. In this thesis, the use of “a source terminal” can also refer to “a previous terminal” and “a destination terminal” can also refer to “a next-hop terminal”.diversity order of this transmissions scheme is limited to the value of one.

A. Medium Access Control (MAC) Protocols for Cooperative Communication

The medium access control (MAC) layer which just lies above the physical layer is also an important area to exploit cooperation. Different from the task of the physical layer which is to process signal, MAC layer is designed to coordinate the multiple nodes participating in the transmission. The Protocols should be tailored to the application requirements and constraints of the sensor network. Based on the difference of basic MAC schemes, cooperativeMAC can be classified into: *Random Access-* This class is based on random access MAC such as ALOHA. Many theoretical researches [19-22] have been done to involve cooperation in ALOHA.
Contention Base- Although this kind of access schemes is also random, channel sensing and reserving mechanism greatly enhance the protocol performance. The proposed research will focus on this class. Channel Allocation and Code Division Multiple Access. This class is based on channel allocation MAC such as time division multiple access (TDMA) [18] and code division multiple [19-20]access (CDMA).

B. Operation of Cooperative Communication s

When to cooperate? (Q1) -The nature of this question is to find the conditions when cooperation can be enabled, or the regions where cooperation is beneficial.
Whom to cooperate with? (Q2)- This problem addresses two aspects: a) Who are the helpers (i.e., helper identification)? and b) Who is (are) the optimal helper(s)? According to the entities answering Q1 and Q2, Table 1. gives the four categories of cooperative MAC protocols and some of the typical protocols:
Category I. The source node answers both Q1 and Q2. The source node maintains a table,[20] known as *CoopTable*, by overhearing the transmission of other nodes. According to the entries in the CoopTable, the source node decides whether a

packet should be transmitted through the direct link or the indirect link, as well as which helper(s) will be chosen as the optimal one(s). Among all these categories, Category I is the most popular one. This is because that the idea of Category I is very similar to 802.11 MAC.Hence, it is easier to revise 802.11 MAC to support cooperative links.

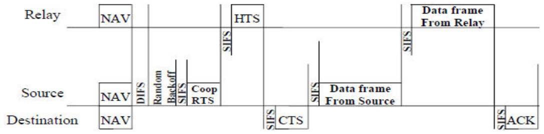


Figure 3.1.3.1: Message flow in CoopMAC.

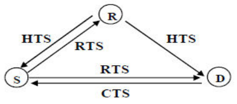


Figure 3.1.3.2: The exchange of control packets for CoopMAC.

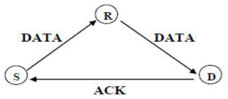


Figure 3.1.3.3: The exchange of data and ACK packets for CoopMAC.

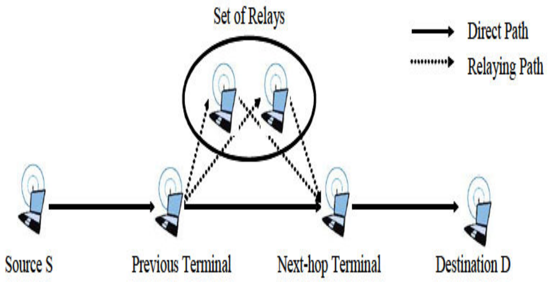
Category	Q1 is answered by	Q2 is answered by	Example protocols
I	Source	Source	CoopMAC [6], rDCF [24], ErDCF [25]
II	Helper(s)	Helper(s)	Distributed MAC [23], ORP [26]
III	Source	Helper(s)	
IV	Helper(s)	Source	

Table 1: Categories of cooperative MAC protocols.

Category I is very similar to 802.11 MAC.Hence, it is easier to revise 802.11 MAC to support cooperative links.

Category II. The helpers answer both Q1 and Q2. Every node who overhears a packet transmission is a potential helper. Each potential helper estimates and decides whether to cooperate, which is to answer Q1. If it is able to help, a handshaking signal is sent, which indicates that the cooperation is ready. Afterwards, to answer Q2, a helper contention procedure is followed to select the optimal helper with the shortest response time [20]. Category III and Category IV. In Category III, the source answers Q1, while the helpers answer Q2. In Category IV, the helpers answer Q2, while the source answers Q1. To the best of our knowledge, there are not cooperative MAC protocols which fall into Category III and Category IV yet.

The CC in our case is using the COOP-MAC protocol. This defines new protocols by enabling additional collaboration from stations that otherwise will not directly participate in the transmission.



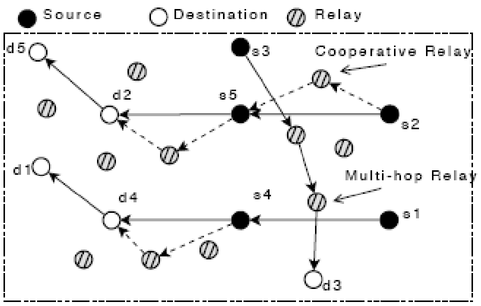


Fig. 4. Cooperative communication scenario in multiple hop networks.

C. Cooperative Transmission Modes

Once a cooperative transmission technique has been selected, the cooperative transmission protocol should also decide whether a relay must always forward the source message or not. When the relay always forwards the source message, we refer this option as fixed relaying. Other options include adaptive relaying schemes (Nosratinia et al., 2004; Ribeiro & Giannakis, 2006; Sendonaris et al., 2003a;b).such as selective relaying and on-demand relaying.

1) *Amplify and Forward(AF):*Under this mode, helper node r receives, amplifies, and forwards the signal from source node (analog form) to destination node.
2) *Decode and Forward(DF):*Helper node first decodes and estimates the received signal from source node , and then transmits estimated data to destination node.

Fixed relaying: In a fixed relaying scenario, relay terminals are always relaying the source message. In DF transmission, the source message is always forwarded by the relay..The cooperation of source-relay nodes in wireless networks towards improved performance & robustness requires the application of an efficient bandwidth sharing policy. The flexible proposed design architecture of the Medium Access Control(MAC) protocols for CC networks, can gain benefits of spatial diversity while a single-antenna is required in each terminal. This idea is attractive in wireless environments due to the diverse channel quality, limited energy and bandwidth resources. When a source terminal transmits a signal to a destination terminal through its direct path(S-D), other terminals such as the helper can overhear the signal. As a result, the two received signals at the D terminal are combined to achieve a better spatial diversity compared to the one achieved with a single direct path. Source Destination can also represent a current terminal and next hop terminal in multi-hop networks.

Since the MAC scheme is contention based and the transmission rates vary widely, if all the stations have uniform traffic to and from the access point, the low data rate stations will use much more channel time than the high data rate stations. This results in a significant degradation of the network throughput as well as average delay.

In view of low fairness problem a new MACprotocol is proposed that can achieve a better performance and provide fair service. Such an approach would reduce interference and improve coverage in an area covered by multiple access points. This approach is backward compatible with current IEEE 802.11 protocol. It has advantages high gain in performance, get a better and more balanced QoS(Quality of signal) throughout the system, would be able to make an unplanned rollout, and generally also enjoy a significant cost savings.

CC systems have wide range of applications of in communication involved in Biomedical, Agriculture, Satellite and in Military and Defense areas.

III AGRICULTURE APPLICATIONS

Wireless sensor networks are used to perform sensor measurements under a variety of conditions. In settings with sparse distribution of sensor nodes, multi-hop routing is traditionally used to forward information from a source node to a destination node. CC approach improves connectivity over 50% compared to multi-hop approaches and reduces the number of nodes necessary to provide full coverage of an area up to 30%.

Wireless sensor networks gain more and more attention as an instrument for fine-granular measuring of a physical parameter in a given area. In the previous years, research communities have developed several different wireless sensor network platforms, such as the Motes [26] or Smart-Its [27], [28]. Mentionable business is already being generated through this emerging technology [29]. The sensor nodes are normally distributed over a certain area to give information on relevant physical parameters or events. The measurements taken are then locally interpreted or forwarded to a base-station for further data processing. To forward the data in such a sensor network, the nodes normally perform refer Fig. 4. *multi-hop routing*. Different methods and strategies to optimize this data-flow process have been proposed and compared against each other [30]. If two nodes in this route are not able to communicate to each other because they are too far away to send/receive RF-signals the network is segmented. This can happen due to environmental conditions – e.g. higher noise on the channel – , the failure of nodes or simply by wrong set-up of the sensor network.

CC is an ideal means to tackle the threads that are introduced by bad connectivity or sparse settings in general. With cooperative communication, a group of nodes can combine its emission power and achieve a higher emission power as a whole. To do so, cooperatively transmitting nodes emit identical symbols synchronously to superimpose the emitted waves on the physical medium. The destination receives the sum of waves and thus a higher total power. The more nodes cooperatively transmit, the higher will the power on the physical medium be. With the higher power,the nodes can reach destinations that are very far away. Fig.5. shows two nodes with their emission range and the emission range of their combination.

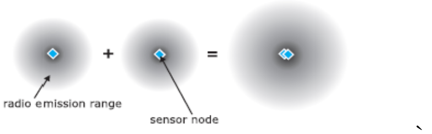


Fig.5. Increasing the emission range by summation of the radio power

A. Transport Scenarios

Different transport scenarios will be discussed and simulated in the remainder of this paper. We distinguish mainly two types of transport scenarios which we consider the most relevant for sensor networks: the *peer-to-peer scenario* and the *access point scenario*. In the latter, we assume that there is an access point – located in the middle of the sensor field – that has a very high transmit power directly reaching all nodes in the field. The nodes are low-power devices and cannot reach the access point in a single-hop manner. Additionally, the information flow is only between the access point and the nodes. Information exchange between nodes in a peer-to-peer manner is not foreseen. Communication with other nodes is only with the intention to relay packets to the access point. In this scenario a node is considered connected if it can forward or route a message towards the access point using whatever technique.

In the peer-to-peer scenario, we want to transport information between arbitrary pairs of nodes of the network realizing a mesh connectivity. This is e.g. useful if the information gathered with sensor is directly used in the network and the topology does not foresee an access point. Here, we call nodes connected when they are able to exchange information between each other using routing or cooperative transmission.

B. Communication Principles

To compare cooperative transmission to traditional approaches, it is necessary to clearly distinguish between different communication principles.The optimal power control for cooperative transmission scheme is e.g. an NP-hard problem [33]. Therefore, we want to discuss different pragmatic principles in the communication. For the comparison, we distinguish between four different types of communication principles:

1. traditional multi-hop communication (flooding)
2. wave propagation cooperative transmission
3. accumulating cooperative transmission
4. ideal hybrid multi-hop cooperative transmission

The following sections will discuss and explain a situation where a node (no. “0”) wants to forward a message to a destination (no. “6”) using the four different types of communication. Figure shows the reference scenario. This scenario is an example for both transport scenarios. The node 6 could be the access point or an arbitrary peer. The small network in the example is heavily partitioned. Node 0 can only communicate with node 1 and there is another cluster consisting of nodes 3, 4 & 5. Node 2& 6 are completely isolated. We assume no further knowledge about the topology for this transport 3 process. The nodes can be mobile and the connectivity may change over time. Therefore, we choose a straight-forward communication principle for all further scenarios: *broadcast communication*. The remainder of the section discusses the performance of the communication principles based on this scenario.

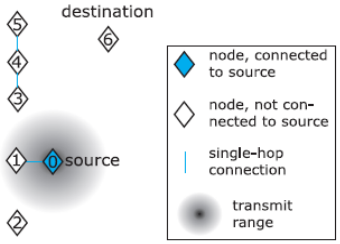


Fig.6. The communication scenario: node 0 (source) wants to forward a message to node 6 (destination).

1) Traditional Multi-hop Communication: As shown in Fig.6. node 0 can communicate to node 1 and vice versa. After node 1, the multi-hop communication is finished as the distance to the next nodes is too high. Node 0 can’t find a multihop route to node 6 and therefore can’t deliver its message.

2) Wave Propagation Cooperative Transmission: When nodes use the wave propagation cooperative transmission, each node will repeat a received message once. It will do this together with all other nodes who at the same time received the same message. This communication principle is very similar to the *opportunistic large arrays* in [32]. The message will propagate through the network like a wave-front. For our example this means that after the transmission of node 0, each node that received the message will repeat it once together with all others. Unfortunately, node 0 can only reach node 1 and therefore the transmission dies out after the second step.

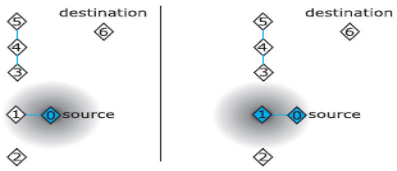


Fig.7. The communication scenario using *wave propagation cooperative transmission.*

3) Accumulating Cooperative Transmission: This principle is a slight modification of the previous *wave propagation cooperative transmission*. It is similar to the *cumulative increment algorithm* in [33]. Nodes that received a message will not only transmit this message once but several times. We set the number of repeats as a system parameter. Using this communication principle, we see the first gains in tackling the problem to deliver a message from node 0 to node 6.

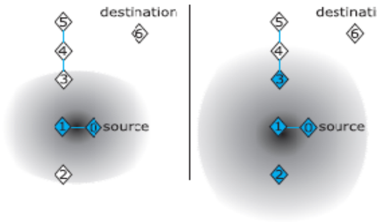


Fig.8 The communication scenario using *accumulating cooperative transmission*.

Fig.8. shows the situation for the first two steps. After node 0 has delivered the message to node 1, they both repeat the message simultaneously and this cooperative transmission leads to summation of energy. The next two nodes (no. 2 and 3) can be reached. In the then following step, the group of cooperatively transmitting nodes includes the partners no. 0, 1, 2 and 3.

Fig.9. shows the last two steps where node 4 and 5 are included (accumulated) in the cooperative transmission that finally all nodes except no. 6 transmit cooperatively. The sum of powers is then enough to finally reach to node 6. For this communication principle, the simple implementation for the *wave propagation cooperative transmission* also holds: For the delivery and relaying of packets, it is not necessary to keep track of connections and paths. Nodes simply repeat a message several times after reception.

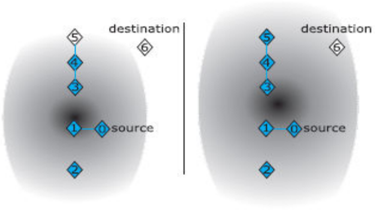


Fig.9. The communication scenario using *accumulating cooperative Transmission*

Nodes can increase their radio range by combining transmit power with their neighbors. With this mechanism it is obvious that the overall coverage will be improved as lost nodes or clusters have a new way to establish a connection which is not possible without cooperative transmission.

IV BIOMEDICAL APPLICATIONS AND COOPERATIVE WIRELESS COMMUNICATION

Biomedical application has following features: It has uniqueness for Healthcare Application. Medical information has higher priority in communication networks. Veridical and time-accurate acquisition of physiological data is extremely important. Patient mobility and Channel Characterization give rise to a dynamic, time-varying environments. Un-compressed video for ECG robot control. Movement of limbs and various postures of human body can be the various data type.

Internetworking Issues: Research shows that How to efficiently allocate bandwidth when integrating heterogeneous wireless networks is a challenge. Consistency medical QoS providing over integrated WiFi/WiMax wireless networks is a challenge research. Efficient radio resource management, scheduling and connection admission control are still open issues in WiMax networks, they are crucial in integrated WiFi/Wimax wireless networks Refer Fig.10. for E-health services. Handover management for seamless integration of wireless networks in E-health service for mobile users & efficiently manage the spectrum to accommodate different application using cognitive radio technology is a challenge issue.

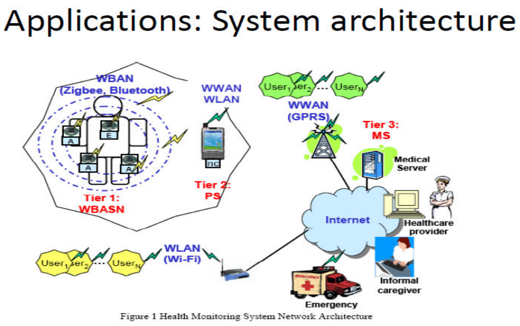


Fig. 10.. Architecture of Cooperative communication.

Applications & Traffic Classification: Medical and non-medical Sensors can be classified as in-body, on-body and around body sensor; or classified as biosensor and motion sensor.Traffic is classified as wave-form real time stream, real-time parameter measurement stream, and video stream.

Network Architecture: A logical connection of communication Types: star, multihop & cluster-based architecture. Performance metrics: PDR,ANR,network life time & inter-user interference. Considerations-power limited, transmission delay, reliability,tissue protection.*Network Architecture:* Spectrum Regulations- WMT Frequencies: 608-614MHZ, 1395-1400MHZ, 1427-1432MHZ. and ISM UWB MICS (Implant medical sensors)

MAC and Routing Protocol: Many new proposed MAC-route protocols are CICADA(Cascading Information Retrieval by Controlling Access with Distributed Slot Assignment).Battery Dynamics Driven TDMA. DQBAN(Distributed Queuing Body

AreNetwork):Hybrid slotted TDMA/CSMA & CCA/TDMA.

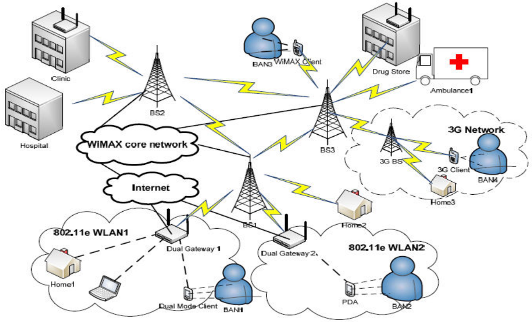


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Fig.11. Interworking

V COOPMAC COOPERATIVE SETUP METHOD

Since every terminal of CoopMAC method[18] is assumed to work in the CCmode all the time; cooperative mode activation signaling is not required. Each terminal internally activates itself to work in the CC transmission. The mode activation allows each terminal to passively listen to all ongoing transmissions and create the “CoopTable”. For cooperative mode notification, the chosen relay is notified by *a modified RTS frame* (called CoopRTS) sent from the source terminal as shown in Fig.3.1.3.1. In CoopRTS, three new fields are appended to the RTS frame, which are the MAC address of the chosen relay, RSR, and RRD.When terminal R receives the modified RTS frame, it checks if the RSR and RRD can be sustained. Then, a helper ready to send (HTS) packet [18]*derived from CTS frame* is unicastly sent from terminal Rto S. When terminal D hears the HTS frame, it unicastly send a CTS frame back to terminal S to reserve the channel for a two-hop transmission via the chosen relay terminal. Illustrations of the message flow, exchange of control packets, and the exchange of[18] data/ACK packet for CoopMAC shown in Fig.3.1.3.1, Fig.3.1.3.2 and Fig.3.1.3.3,respectively.

VI COOPERATIVE COMMUNICATION STRATEGIES FOR SATELLITE

Satellite communications have become an important node of the global telecommunication infrastructure. Satellite capacity request is growing quickly, driven not only by broadcast applications but, mainly, by broadband services, in particular by the expectation of “always-on” broadband services available everywhere. Thus, new “killer” applications such as HDTV (High Definition Digital Television)[16] and broadband Internet access, provided through satellites, can help to face the growth of capacity demand foreseen in the near future. Moreover, in addition to the provision of satellite multimedia services to fixed terminals, there is an increasing demand for broadband communications on the move (i.e. on ships, trains, aircrafts, vans, cars). Analysing such demand of satellite communications, [17]the work reported in this paper focused on the study of different techniques which allow the improvement of the performance of satellite users displaced in severe environments. The analysis of this context, in fact, has revealed the need to adopt adequate advanced techniques to achieve a sufficient quality in satellite links, especially in those scenarios where the link budget is tighter, such as, for example, the mobile satellite one. These considerations have motivated the study of CC strategies which allow the mitigation of the deleterious effects of fading. The diversity gain can be achieved through the cooperation of different users which generate a virtual MIMO (Multiple-Input Multiple-Output) system. The adoption of these methodologies can be very helpful in NLOS (Non-line-of-sight) and LOS (Line-of-sight) channel conditions and, therefore, it is interesting to assess their implementation in critical satellite [26] contexts. A new class of techniques, called CC techniques which require the deployment of additional antennas in order to mitigate the fading effects. A group of mobile terminals can share their single antennas in order to generate a “virtual” multiple antenna, obtaining the same effects than a MIMO system, (Nosratinia et al., 2004; Ribeiro & Giannakis, 2006). This approach can be seen as a new form of spatial diversity in which, however, the diversity gain can be achieved through the cooperation of different users, opportunely grouped in[14][15] clusters, which can assume the double role of active user, i.e. the user which transmits its own information data and cooperator, i.e. the user which “helps” the active user in its transmission, (Sendonaris et al., 2003a;b).The key concept is that each user sees an independent fading process , data transmission through different paths, as shown in Fig.4.

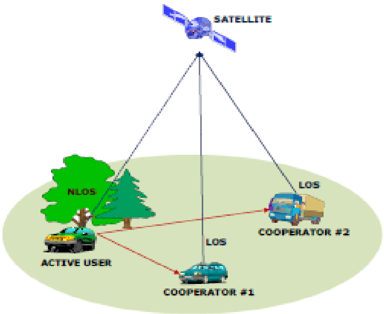

Fig.12. Satellite cooperative scenario

An effective way to mitigate fading is to supply the receiver with multiple [15] replicas of the same information-bearing signal transmitted over the channels. Because of this independence, the probability that all the considered signals are simultaneously vanishing due to fading, is considerably reduced. If p, (0 _ p _ 1), is the probability that any signal is faded below a threshold value,+ that all L independent fading channels, containing the same signal, are faded below the[14] Threshold value, Ptot, it is lower than p,(Lee& Chugg,2006).

$$p_{tot} = \prod_{i=1}^{L} p = p^L$$

The CC approach turns to be useful for mobile terminals, because of their size constraints, cannot support multiple antennas and it allows them to increase their performance in terms of Bit Error Rate, Packet Error Rate and Outage[14] probability. The scenarios has been applied so far are, mainly, the cellular networks, the wireless sensor networks and the ad hoc networks, in mobile satellite scenarios which are characterized by the continuous occurrence of LOS and NLOS conditions.

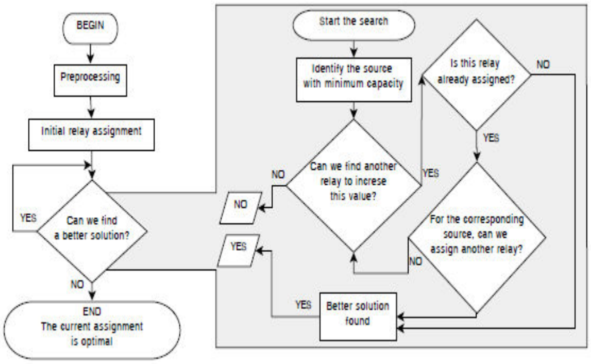

Fig. 13. Flow chart illustrating an exemplary method performed by a source station in a COOP MAC & Optimal relay assignment .

VII SATELLITE ACCESS AND CRITICAL ISSUES

Satellite communications have developed a global success in the field of digital audio/TV broadcasting because they offer a wide coverage area and, therefore, they are suitable for the distribution of multimedia contents to a large number of potential users, also in rural environments. Moreover, they allow the extension of the coverage area of terrestrial, fixed and mobile, networks. One [15][17] of the most interesting example concerning this capability, is provided by In marsat which is a broadband global network service for mobile terminals on land, at sea & in the air. Users can send and receive voice and data services nearly everywhere on Earth. In particular, in some specific cases as the transoceanic maritime and aeronautical communications, satellites are the only practical solution to telecommunications requirements. Broadband satellite systems can also help to bridge the digital divide because they can provide a rapid deployment compared with other terrestrial infrastructures, without gigantic investments and create new opportunities for human development. Applications like telemedicine, e-learning or simply an easy access to information can allow economic activities to grow and develop. Satellite systems can allow a multitude of valuable services and applications to emerge. Besides for commercial services such as broadcasting, multimedia transmission and broadband services, the use of satellite for telecommunication is also considered for other application scenarios such as public services, emergency services, data relay services, etc. For example, the monitoring[15][16] and the protection of critical infrastructures such as pipelines and oil platforms, depend on data transmission via satellite. The benefits of satellite communications are well visible also in emergency applications.In case of floods, earthquakes, volcanic eruptions and other major disasters. In such a situation, satellites can flexibly connect different first responder team clusters over large distance across incompatible standards. In fact, for large disasters, only satellites are actually able to cover the whole scene and provide broadband services. A satellite communication component is considered in the Air Traffic Management scenario, as well.However, analysing all these scenarios, some critical issues in the use of satellite systems, common to many contexts, can be highlighted. In particular, the presence of link impairments and[27][28] fading conditions (multipath, long periods of shadowing and blockage) or the mobility effects (occurrence of visibility and not visibility conditions) require the adoption of solutions in order not to reduce system performance & capabilities. Moreover, power constraints have to be taken into account, as well, especially in case mobile terminals are considered.

VIII SECURITY ISSUES

The first potential security issue in the CoopMAC protocol is that of the helper deliberately not forwarding frames received from the source. In this case the helper could deny service to the source by simply dropping the packets it receives. It would then be up to the source to realize that this helper is unresponsive and choose another helper. If another helper does not exist, it can then transmit directly to the destination, albeit at a lower rate. The source[23]could detect the responsiveness of the helper or lack thereof, by imposing some kind of a timeout, after which if no acknowledgment from receiver is received, it would blacklist the helper and try to retransmit via a different helper, if available, or directly. The second potential issue is more serious. The malicious helper may try to deny service to the source by failing to forward data and spoofing an ACK on behalf of the destination, thereby making the source think that the data was received. Here, we may try to combat this problem via the aid of RTS/CTS. COOPMAC uses some variant of the RTS/CTS scheme. This means that the destination sends the CTS, and is aware that it is an intended recipient of a future frame.

The third and the most important potential security issue is a scenario where the helper modifies the payload and then forwards it. The receiver will typically not come to know of this, so it will think that it is only communicating with the genuine sender and may end up voluntarily with replying with privileged information, such as username and passwords. This type of an attack is possible when changes made in the payload will not lead to corruption of the packet, i.e. when no wireless encryption scheme is used or if the WEP scheme is used. If no wireless encryption scheme is employed, then it is obvious that no mechanism exists to detect the alteration. of the payload. However if we implement CoopMAC according to the protocol which requires the retransmission of the packet by the helper in a SIFS interval this type of attack will not be possible as the SIFS duration is very small to perform any kind of complex calculations and manipulation of the packet. Finally, 802.11i security protocols are not vulnerable to the modification of payload unless the exact key is known to the helper.

Security protocols used in 802.11i.

TKIP: Temporal Key Integrity Protocol is a security protocol used in Wi-Fi Protected Access (WPA). CCMP: Counter Mode with Cipher Block Chaining Message Authentication Code Protocol is an IEEE 802.11i encryption protocol, Single or Two header scheme of format

Performance Discussions

These numerous detrimental factors essentially lead to trade- offs which we also discusses, coverage versus capacity, hardware complexity, interference, ease-of-deployment and cost versus performance.Performance of the CC network up to 5 times better with the existing technology of IEEE 802.11. Generally apply different design principles-Control requires fast, accurate, and reliable feedback. Networks introduce delay and loss for a given rate. Sensors must collect data quickly and efficiently. The controllers must be robust and adaptive to random delays and packet losses. Control design today is highly sensitive to loss and delay. The networks must be designed with control performance[24][25] as the design objective. Network design tradeoffs (throughput, delay, loss) become implicit in the control performance index. This complicates network optimization. Refer Fig.14-15.

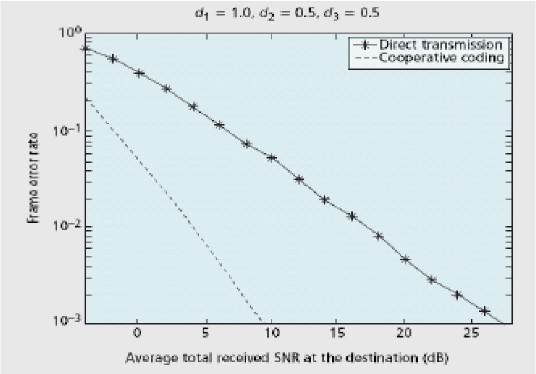

Fig.14. Performance Metric of CC

Spatial Multiplexing Gain:

$$\lim_{\mathsf{SNR}\to\infty} \frac{R(\mathsf{SNR})}{\log \mathsf{SNR}} = r$$

Diversity Gain:

$$\lim_{\mathsf{SNR}\to\infty} \frac{\log P_e(\mathsf{SNR})}{\log \mathsf{SNR}} = -d.$$

Trade Off:

$$d^*(k) = (m-k)(n-k).$$

Cross layer design is effective in sensor networks. Cooperative gains depend on network topology application. Cross layer design must optimize for application require interdisciplinary understanding, e.g. for control. Potential design autonomy: Subsystems can operate in absence of global data Estimation, prediction, and planning Exploit rich set of existing tools. Command buffering and prefetching. Increases learance to data latency and loss. Time stamps and delay-adaptive control. Modular design Supervisory control via models, cost functions, modes

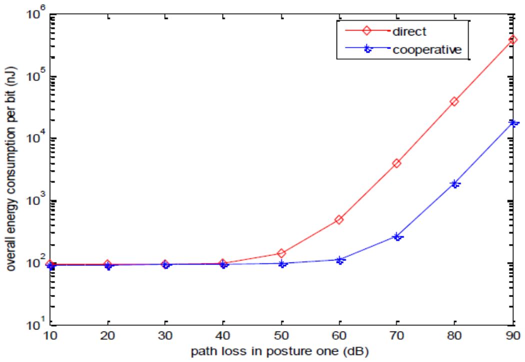

Fig.15. Overall Energy Consumption in CC

IX FUTURE SCOPE

The cooperative transmission system can be extended to a multihop scenario by concatenating multiples of the three-node or the dual-hop networks. With cooperation, the receiver may combine signals transmitted via different relays, regardless of the signal strength, to enhance the detection performance or to reduce the energy consumption. The gain in energy efficiency and the respective power allocation strategies have been studied. Instead, A multipath fading is resolved by the RAKE receiver or some equalization technique. The design challenges encountered renders to the implementations of the suggested techniques allow the WEP, WPA and WPA2 (802.11i) security protocols to successfully operate in the new cooperative environment.

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