

Research on Mobile Computing based on Event Choreography Technology

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Abstract.

This paper presents an event model which describes the data structures that are realised in mobile computing. The model is divided into two different types, namely atomic events and composite events, and provides the means for the classification and package of events. From the perspective of complex networks, a kind of event choreography network(ECN) is constructed, a formal definition is proposed for event ontology, and ECN construction and its features are analyzed. The results show that ECN simplifies the analysis of choreography relationship between multiple event nodes.

Keywords: mobile computing; event; choreography

Introduction

With the development of wireless communication networks and mobile terminal equipments, computing activities are expanded from PC to mobile terminals, so a new computing mode, namely mobile computing, has been created[1]. In order to improve the reusability of mobile computing resources, when a mobile computing system can not find a resource to meet the needs of learners, more functionality-limited resources should be used unitedly and be made up flexibly according to the shared context strategies, resource descriptions, constraints, etc. The mobile computing system should get a large granularity of computing resources in order to achieve combination targets defined by learners. At the same time, mobile computing operators and business developers can also take measures to aggregate mobile computing resources on its own initiative, quickly develop

value-added mobile computing services that meet the individualized computing needs, and solve a long-term lack bottleneck of mobile computing business[2].

Event choreography technology refers to a process that provides a new application by combining existing events, its purpose is to provide an event model that describes the data and the relationships between them that is needed to define a choreography that describes the sequence and conditions in which the data exchanged between two or more participants in order to meet some useful purpose[3, 4]. Today, more and more mobile computing resources becomes available, event choreography is a suitable paradigm for architecting mobile computing oriented applications. Functional requirements of event choreography applications often change, and mobile learners' needs are different, which lead to characteristic analyses of event choreography groups remain still an open issue[5].

In view of the above analysis, an approach, for analyzing characteristics of ECN, is presented. The main characteristics include two aspects as follows: Firstly, focusing on application development, we put mobile computing resources as a events, define event and its classification characteristics. And then, we construct a event ontology model to complete ECN construction, and analyze ECN' features.

Event model of mobile computing

The event model describes the data structures that are realised in mobile computing. Since functionality of mobile computing is implemented by events, the events are divided into two different types, namely atomic events and composite events. From the perspective of semantic, the events are reclassified and packaged by the events' content structure. Design concept of the content structure is based on the realization of structured resources and content interoperability.

Atomic event. Atomic events are the smallest structures of mobile computing resources in the semantic level. Atomic event layer is mainly characterized by independent events, which are packaged by a variety of mobile computing materials according to certain semantic relations and rules.

Definition 1 atomic event. Atomic event can be represented by 6-tuple, and denoted as $AC=(Nav, Q\&A, CU, EI, Case, UD)$. The meanings are as follows: Nav represents the static directory contents of mobile computing resources, describes the static structure of content objects. Q&A represents a separate discussion content, which contains one question section and any number of response sections. The response sections aren't limited to the standard answers to that question, may include help, reference, background and other information for the question. CU represents a body of computing content on semantic level, and includes computing content, help content, suggesting content etc.. EI indicates the smallest unit of an exercise or a test, it only contains the part of test subject, and does not include the part of standard answer. Case indicates the smallest sample units, it includes not only the part of problem, but also the part of standard answer part. UD represents an user-defined semantic content body, which is the smallest unit on semantic level.

Composite event. Composite event is formed by different atomic events, and carries certain goals. Composite event layer is mainly characterized by content objects, which are aggregated by atomic events according to certain semantic relations and rules.

Definition 2 composite event. Composite event can be represented by 5-tuple, and denoted as $AC=(Les, Prj, Agn, KB, Exe)$. The meanings are as follows: Les represents content bodies on semantic level, which supports a complete, independent minimum process. Prj includes thesis, experiment, and other project content. The other project content can't be classified as thesis and experiment, and include an user-defined content body aggregated by atomic events. Agn represents a complete process for reaching a certain goal. KB represents the collections of knowledge, which are aggregated by problems, and classified according to the various subjects of knowledge. The design of knowledge collections try to introduce public knowledge, expertise and computing community knowledge into the mobile computing content framework. Exe represents a complete paper resource, which is assembled by atomic events, such as exercise test events.

Event choreography network

With the continuous maturity of mobile computing technology, and the improvement of relations between the events, the networked nature of events is highlighted. From the perspective of complex networks, we constructed a kind of ECN.

Event ontology. Event, as a basic unit of ECN, is a starting point of whole research process of ECN. In view of new characteristics of ECN, we describe events from an ontological perspective.

Definition 3 event ontology. Event ontology can be represented by 8-tuple, and denoted as $EO = \{eN, eID, eW, ePro, eInt, ePol, eQoS, eCR\}$. The meanings are as follows: eN represents an event name which follows the camel-style naming conventions, that is, names of event start with lower-case letters, and use upper-case letters at the start of each word in the name. eID uniquely identifies an event, and is composed according to certain rules. When providing event registration services, registration center must set $eIDs$. Weight is given to eW , which indicates the popularity of events, the number of calling, and usefulness etc.. $ePro$ describes an event purpose, type, the prerequisite for the successful implementation of an event, as well as the execution results. $eInt$ represents event interfaces, which describes how an event is called, expresses event related operations and the input and output information. $ePol$ indicates event service strategies, including security, transactional, constraint and other strategies. $eQoS$ represents quality of event service, it describes the stability, integration and credibility of an event. eCR describes the event charge rules, including billing type, charge description, the price of services. eN , $ePro$ and $eInt$ is required, the other items are optional.

ECN construction. ECN is composed of event groups, which can be divided into three kinds of granularity, including event node, aggregation node and Sub-ECN node. An aggregation node is composed of multiple event nodes according to a certain structure, these event node has a choreography relationship. A Sub-ECN node is composed of multiple aggregation nodes which are relevant,

A ECN is a network of Sub-ECN nodes that communicate with each other. Fig.1 shows a ECN. ECN has the following features:

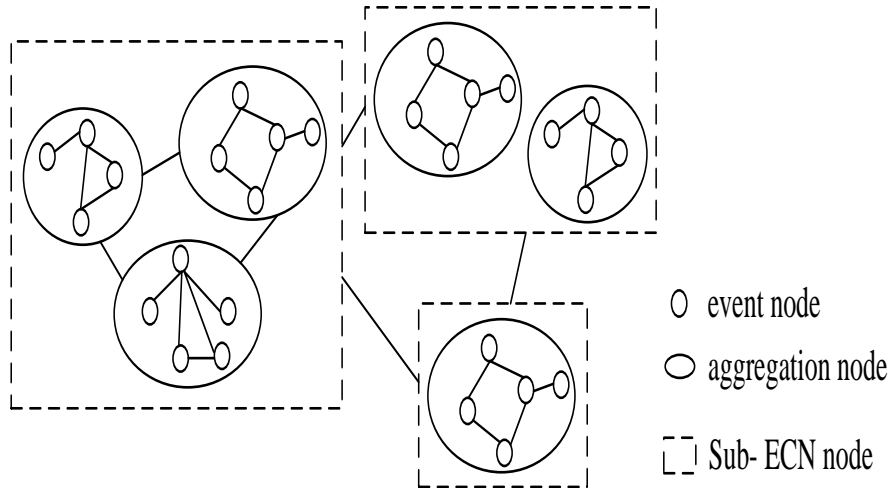


Fig.1. ECN

(1) Autonomy. ECN is organized by spontaneous and autonomous behavior of independent nodes, rather than is organized by the centralized control or plan.

(2) Evolution. The evolution of ECN is distributed control, which is from the bottom to the top or from the local to the global. Local rules apply to a local network evolution without any centralized control. Even if the initial structure of network is pre-designed, but the result is the evolution of network's dynamic behavior.

(3) Usefulness. Usefulness is an important characteristic of ECN, and is often expressed as the other forms, such as influence, strength or like degree. The usefulness of ECN relates to these factors, such as the number of nodes, the number of links, and network density.

Characteristic analysis of ECN

In this section, we define the topology of ECN, and thus facilitate the study of the overall characteristics of event choreography group which has a large number of

event nodes, while simplifying the analysis of choreography relationship between multiple event nodes.

Definition 4 ECN topology. ECN topology can be represented by 3-tuple, and denoted as $ECN-T=(EN, PL, Fun)$. The meanings are as follows: $EN=\{event\ node_1, ..., event\ node_n\}$ is an event node set, $n=|EN|$ is the number of event nodes in the S. $PL=\{process\ link_1, ..., process\ link_m\}$ is a process link set, $m=|PL|$ is the number of process links in the PL. $Fun: PL \rightarrow EN \times EN$ maps process links to event nodes pairs.

We do not consider that the elements in ECN-T changes over time, and it is assumed that EN, PL, and Fun in the whole life cycle of ECN-T are constant. We focus on an analysis of the whole network attributes and choreography relationships between event nodes, so the constructed ECN-T is an undirected graph. Characteristics of ECN-T include the following fields:

(1) Event node degree. The degree of event node_i is defined as the number of process links which has choreography relationships with the event node_i, and denoted as $deg(event\ node_i)$.

(2) Degree sequence. Degree sequence is defined as the set of ECN-T event node degrees, and denoted as $g=[deg_1, ..., deg_n]$. The elements in the g have characteristics of irregularity.

(3) Degree sequence distribution. Degree sequence distribution is defined as a distribution function of the degree sequence, provides a classification mechanism of ECN-T graph according to its topology, and denoted as $g'=[h_1, h_2, ..., h_{max-d}]$, Where h_{max-d} is the part event nodes which have the maximum degree in ECN-T.

(4) Hub node. Hub nodes is defined as event nodes with the greatest node degree, they have the most concentrated choreography relationships in ECN, and denoted as $Hub=\max\{deg(event\ node_i)\}$. A ECN can contain one or more Hub nodes.

(5) Diameter. Diameter is defined as the longest process link between any two event nodes in ECN-T, and denoted as $dia(ECN-T)$.

(6) Radius. The radius of the event node_i is defined as the longest process link from the node to all other event nodes, and denoted as $\text{radius}(\text{event node}_i) = \max\{\min\{\text{path}(\text{event node}_i, \text{event node}_j), j \in [1, n]\}\}$.

(7) Center. The center of ECN-T is defined as the event node with the smallest radius.

(8) Betweenness centrality. Betweenness centrality. The betweenness centrality of a event node event node_i is given by the expression:

$$\text{BC}(\text{event node}_i) = \sum_{s \neq i \neq t} \frac{n(i, st)}{g(st)}.$$

Where $n(i, st)$ is the total number of shortest paths from event node_s to event node_t and $g(st)$ is the number of those paths that pass through event node_i. Note that the betweenness centrality of a node scales with the number of pairs of nodes as implied by the usefulness of event nodes in different ECNs.

(9) Graph density. The graph density is defined as the ratio of the number of process links of ECN-T vs. the number of possible process links of a complete graph formed by event nodes, and given by the expression: $\text{density}(\text{ECT-T}) = 2 \times m / (n \times (n-1))$, where m is the number of process links of ECN-T.

(10) Entropy. Entropy provides a measure of randomness, the higher its value the stronger the randomness of ECN. It is denoted as $E(\text{ECN-T})$, and given by the expression:

$$E(\text{ECN-T}) = - \sum_{i=1}^{\max-d} h_i (\log_2(h_i)).$$

(11) Aggregation coefficient. The aggregation coefficient of event node_i is given by the expression:

$$\text{AC}(\text{event node}_i) = 2 \times \text{cnum} / (\deg(\text{event node}_i) \times (\deg(\text{event node}_i) - 1)).$$

Where $(\deg(\text{event node}_i) \times (\deg(\text{event node}_i) - 1)) / 2$ is event node_i' maximum number of possible links, C is the number of links shared by neighbors.

Conclusions

We propose the event model for implementing mobile computing resources choreography. In our future work, we plan to establish a development environment by integrating the event model, and the model engineering tools to provide a basis for the seamless integration of event choreography.

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