GOLLUM

(Generic Open Link-Layer API for Unified Media Access)

The GOLLUM research project

Overview

GOLLUM is a research project started in September 2004 and is supported by the 6th Framework Programme. GOLLUM has an overall budget of 3M€, including 1.8M€ from the European Commission, and will run for a period of 24 months. GOLLUM brings together a consortium of industrial, research, and academic partners with the specific expertise necessary to develop the targeted innovations in networking, middleware and programming interfaces that address the emerging challenges in heterogeneous and mobile networking.

The GOLLUM project aims at studying and creating key parts of an embedded, open, operating system independent link-layer API (ULLA; Universal Link Layer API) to unify the various methods for accessing different wired and especially wireless links. The aim is to remedy the current and very difficult situation where a separate programming interface exists for almost every wireless technology. The existence of such an ULLA API and its corresponding middleware would greatly improve interoperability between various technologies. It would also enable better portability of applications between devices using different communication interfaces. The GOLLUM API is aimed to simplify the wireless access programming as seen by programmers, and at same time provide more flexibility and new features for innovative application usage. If successful, this work has the potential to enable operators and software vendors to provide new kinds of services that greatly enhance the end user's experience.

GOLLUM applications will be able to properly adapt to changes in the network connection, allowing for cognitive", i.e. smart, applications to be developed. An API of this type is also a building block for middleware and embedded systems for intelligent, networked devices. The project will provide not an openly available API specification, but also is doing practical, partial prototype implementations on various commercially viable platforms and different operating systems.

Figure 1: A high level schematic of GOLLUM's ULLA API, Events and queries

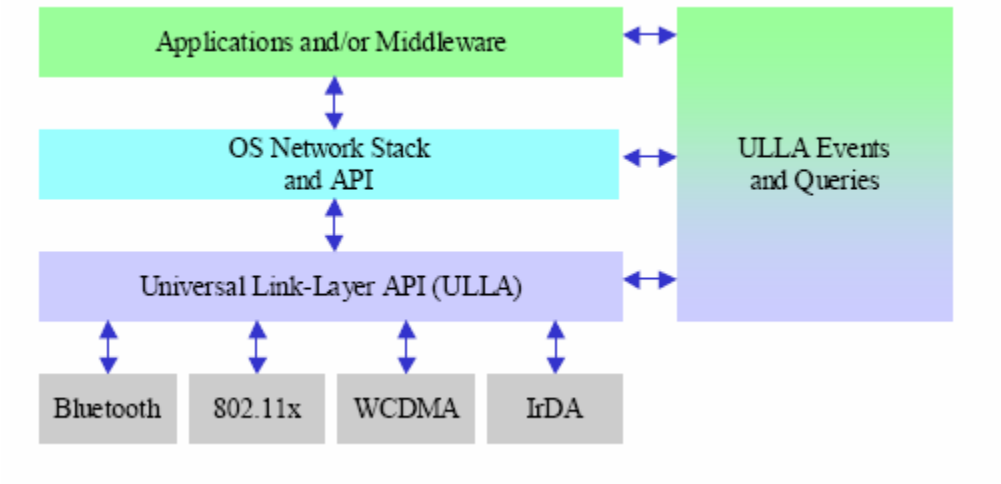
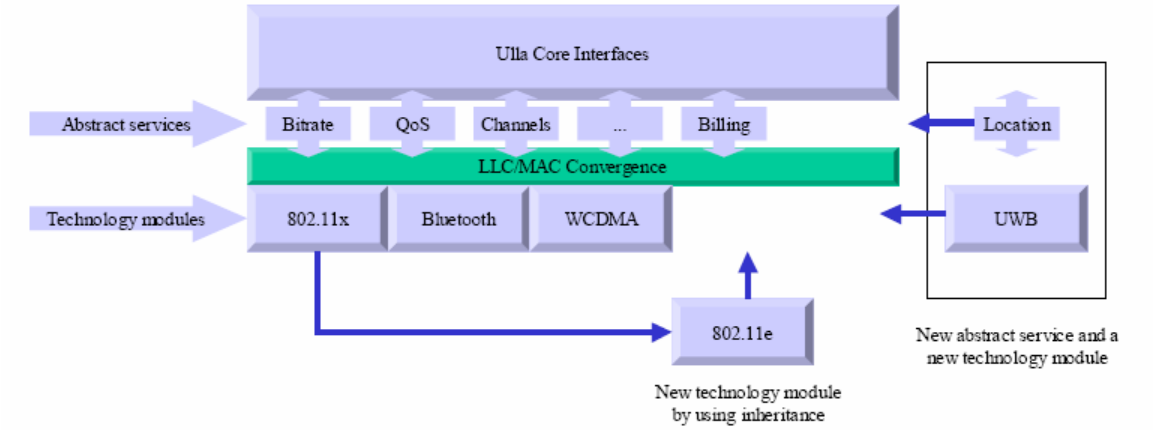


Figure 2: A lower level schematic showing some of the information the ULLA will abstract and manage from heterogeneous networking technologies



Context of the GOLLUM research being done

In the present-day wireless application programmers have to be very mindful of the platform they are writing the applications on and the specific networking technologies they are utilizing. A program designed to work on a mobile phone or smart-phone will probably not work without great modifications on a PDA equipped with a Bluetooth connection, or on a laptop using a wireless LAN. Direct portability for even more embedded devices would be almost unimaginable, and in particular most automation and control systems' radio link layers are completely proprietary without any support from operating systems and application programmers. In part this is because of the large number of different operating systems in use. While unification is progressing in this sector, great problems remain in the other problem area, namely in the interface used to access the wireless access devices or air interfaces.

Even when using the same or compatible operating systems the methods used to access, say, a Bluetooth or GSM/WCDMA link, and a Wireless LAN differ. This difference becomes even greater when many of the small, embedded radios are considered. The situation becomes even more difficult if the application or middleware needs to somehow intelligently respond to some events or changes in the wireless channel. The necessary mechanisms are usually simply not there, and even in the cases that they are available, they again are different form one technology to the other.

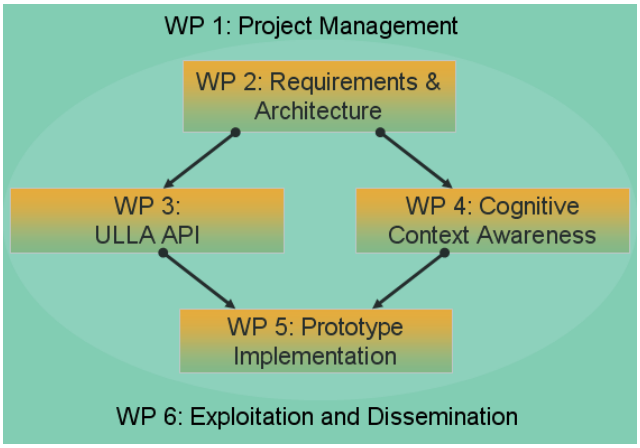
With this background the necessary development seems clear: a unified API of sufficient generality and extendibility, and the corresponding embedded middleware, need to be investigated and developed. This is precisely what GOLLUM aims to do.

Objectives and expected results

The following is a list of GOLLUM's objectives and expected results. Results will be applicable to, for example, wireless controls, industrial processes, automotive applications, mobile and wireless terminals, PDAs, tablets and laptop computers.

- Solving the complexity and interoperability problem related to the large number of different APIs and methods used for accessing communication interfaces, especially in the embedded domain.
- Providing real and useful triggers, handles and APIs for different smart, context sensitive and link/network aware applications; enabling the development of "cognitive applications". As a concept this is a well-known paradigm and goal. The problem is that no really acceptable and useful reference API has been provided to the public domain.
- Solving the abstraction and extendibility problem related to different underlying wireless interfaces and networking technologies.
- Designing, developing and in part implementing a solution to abstract the embedded communication network in a way that is meaningful and useful to middleware, application and operating system programmers.
- Developing a wireless interface description method that can be used as a tool and as a framework for presenting and extending the API support for current and future wireless interfaces.

GOLLUM work-plan and methodology



The main research and innovation activities in the project are the design of the ULLA, and the corresponding middleware integration and "network trigger" components. Before this research can commence, fundamental architecture design and investigation of the precise requirements is necessary. The architecture model and requirements also need to be updated during the project lifetime. These considerations motivate the existence of three research and development work-packages. They are:

WP2 – Architecture Definition and Requirement Analysis
WP3 – Universal Link-Layer API
WP4 – Cognitive Context Awareness

Prototype design and implementation, and other experimental and reference implementation issues are critical to the success of the GOLLUM project. Therefore, it warrants having a prototype-specific work-package:

WP5 – Prototype Implementation

WP4 houses the research of the middleware integration, as well as all the work for enabling cognitive applications and middleware, including the "network triggers".

The WP3 and WP4 are dependent on WP2 providing the requirement and architecture specification. WP4 depends on the ULLA definitions (draft and final) obtained from WP3. WP5 depends on the implementations of WP3 and WP4.

For the project management and dissemination and exploitation of the results, two dedicated non-technical work-packages exist. They are:

WP1 – Project Management
WP6 – Dissemination and Exploitation

Technical work packages

WP2 – Architecture Definition and Requirement Analysis. The work in this WP has begun by considering the interactions between existing applications, middleware components, and OS networking stacks and the various link-layer types. The architecture design has a strong focus on wireless technologies, especially on those applicable to the embedded and mobile device domain.

WP3 – Universal Link-Layer API. This is the heart of the project, defining the ULLA API. Naturally this definition is following the requirements specification and the architecture documents obtained from WP2.

WP4 – Cognitive Context Awareness. The fourth WP focuses on the middleware issues and on "network triggers". The initial work carried out here will result in a specification of an ULLA middleware support module. This design will incorporate the methods for exposing link-layer information from ULLA to the middleware, and the techniques for defining "network triggers" for specific changes in the link-layer and application context.

WP5 – Prototype Implementation. The implementation and prototyping activities for the ULLA API and corresponding middleware components will be integrated in this WP into working prototypes running on the target platforms. Feedback from this work package will go into iterative improvements in WP2, WP3 and WP4.

Non-Technical work packages

WP1 – Project Management. The project-level and technical management of the project takes place here.

WP6 – Dissemination and Exploitation. This work-package is responsible for the consortium-wide exploitation activities. Is consists of work such as preparation of standardization of the technologies and APIs resulting of the project work, as well as other exploitation and dissemination work in the GOLLUM project.

Application scenarios

Heterogeneous network access from device applications

Advanced mobile devices today, and most mobile devices in the future, will need to operate in heterogeneous network environments, making decisions about which networks to choose given the presence of different networking technologies such as flavours of Wi-Fi, Wi-Max, GMTS and UMTS, as well as choosing from multiple network operators that may be providing each of these capabilities simultaneously. To make these decisions, as well as deal robustly with future

networking technologies, a common mechanism for querying network capabilities is necessary. This mechanism must cross different networking technologies, deal with legacy systems that may provide only partial information and offer a consistent model for future networking technologies to adopt. This is a core application of GOLLUM's technology development.

Adaptive streaming and provisioning of content

An important class of mobile applications involve real-time streaming of voice and video. Frequently the software that sends and receives these data streams will need to work over multiple types of networks. The creation of a unified mechanism for getting QOS data from different types of networking systems will allow these applications to make intelligent decisions on buffering, media richness (e.g. voice vs. still photos vs. live video) and transfer bit rates.

Other kinds of mobile applications may deal not with live streams, but with bulk data transfers that are not as QOS driven as media streaming, but nevertheless can benefit from device provided feedback on channel to be used for the data transfer. Different mobile applications, each depending on its own specific needs, will have different strategies for caching data locally, queuing data for transfer and performing transactions. The information provided by GOLLUM's ULLA and query capabilities will enable these applications to make more intelligent decisions.

Advanced middleware for dealing with intermittent networks

An important application of the work in GOLLUM is the creation of mobile device middleware to greatly simplify the software development process for creating rich network-advantaged software that can robustly deal with heterogeneous, variable, and intermittent connectivity. Not only do devices need to roam between networks and adapt to variable bandwidth due to factors such as data traffic congestion and latency, but also, as users' expectations of the services mobile devices will provide them rise, these same devices will have to deal robustly with intermittent breaks in network connectivity caused by the users' physical movement in the real world. GOLLUM based middleware can greatly aid mobile device developers to deal with intermittent connectivity.

Intelligent connection management

In addition to providing advanced middleware for simplifying new mobile device application development, another important application for the GOLLUM project's efforts is to provide better automatic "connection management" for existing mobile applications. Today's mobile device applications and their users can benefit from increased reliability and more intuitive behaviour by significantly increasing the intelligence of the on-device "connection manager" that makes and monitors network connections for them. All rich mobile devices including desktops, tablets, PDAs and Smartphones have some concept of a "connection manager" that determines how and when to make an Internet connection for their user. Using Gollum's ULLA technology we will demonstrate how this connection management technology can be significantly improved by adding access to multiple layers and classes of network information and also providing built in useful analysis of this data.

List of partners

Academic Partners
RWTH Aachen University
University of Cantabria

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STMicroelectronics
European Microsoft Innovation Centre
Telefonica
Toshiba Research Europe
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