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Project Summary

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Abstract:

Project summary report providing outline details of project's overall objectives, the technical scope, the partners involved and the expected impact of HAP technology.

Keyword list:

High Altitude Platforms, HAP, Communications, Broadband, Technical Summary, Overview, Partners.

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Logo	
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Number of partners :	13

Main objectives :	

The overall objective of the CAPANINA project is to develop a broadband wireless communications capability, at speeds up to 120Mbit/s, from High Altitude Platforms (HAP) to stationary users on the ground and to users on moving vehicles at speeds up to 300km/h.

In more detail, objectives of CAPANINA fall into the three broad groups:

HAP broadband systems, applications, and services.

To develop technologies that will deliver, in the most economical way, low-cost broadband services from HAPs to otherwise inaccessible users.

To perform trials of broadband from an aerial platform delivering services such as high-speed Internet, corporate communications, and video-on-demand to fixed locations.

To construct an outline system design of broadband service delivery from HAPs to high-speed vehicle users.

To inform and influence standardisation, and regulatory bodies such as the ITU, in the field of broadband communications delivery from HAPs.

Broadband communications links, networking, and support infrastructure for HAP systems.

- To assess the *mm*-wave propagation environment from aerial platform architectures through measurements and numerical analysis for both static and mobile scenarios.
- To develop multiple HAP constellation strategies, quantifying how such configurations can enhance capacity and quality of service through spectrum sharing and/or diversity.
- To construct an effective resource management methodology for a single HAP system, illustrating the viability of coexistence with other broadband wireless/satellite technologies.
- To develop and evaluate HAP network architecture(s), which incorporate *mm*-wave band and free space optical transmission technologies.

Broadband communications node technology for HAP systems.

- To evaluate *mm*-wave band steerable antenna technology.
- To develop cutting-edge signal processing technology to achieve smart antennas in the *mm*-wave band for aerial platform architectures and exploit multiple platform diversity.
- To evaluate and test free space optics technology for the eventual delivery of broadband interplatform and backhaul links from aerial platforms.

The project is organised into the following parallel workpackages:

WP1: Applications and Services

WP2: Communications Links and Networking

WP3: Communications Nodes

WP4: System Testbed

WP5: Dissemination and Exploitation

WP6: Project Coordination

Technical approach :

The technical activities focus on:

- Extension of terrestrial and/or satellite technologies to enable HAP service delivery
- Development of cost effective HAP architectures.
- Development of a steerable directional *mm*-wave band antenna for vehicle use
- Low complexity signal processing algorithms that will support *mm*-wave smart antenna technology
- High data rate free space optical links for ground-HAP, HAP-HAP
- High-speed inter-beam and inter-HAP handover that is compatible, from a user perspective, with existing standards.
- Delivery of significant capacity enhancements with novel multiple HAP constellation strategies, exploiting proposed single HAP communications technologies, where users have directional antennas.
- Rain fade mitigation strategies, exploiting temporal and spatial diversity, and caching (e.g. web-caching and content distribution).
- The development of a cut-down broadband HAP communications payload and fixed user terminals connecting direct to the home/SME, or to an intermediate WLAN port, allowing small groups of users to be served (e.g. a village or street). They will use existing/future communications protocols and connect with existing broadband infrastructure. Tests of various applications/services are being developed, such as high-speed Internet, corporate communications, and video-on-demand. The system is being tested on at least two aerial platforms with the intention that a similar system will eventually be deployed on a plane or airship based HAP.
- Propagation measurements, directly applicable to this scenario are being carried out during the trials.
- Viability of optical communications for backhaul (aerial platform – ground) is being assessed.
- Cutting edge research examining broadband access to high-speed vehicles (e.g. trains), interfacing with on-board wireless LAN base stations. Data rates of up to 120Mbit/s to a moving vehicle travelling up to 300km/h are envisaged. The objective is to provide 'broadband access for all', efficiently and at low-cost to the user.

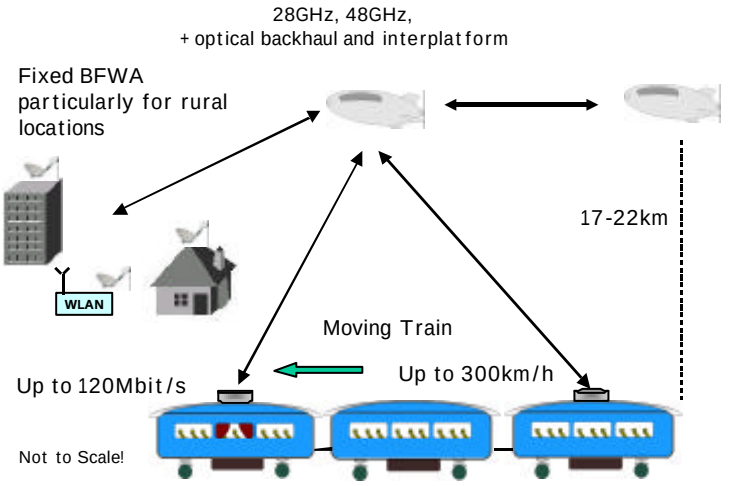

Figure showing top level scenario - communications from HAPs to fixed and mobile users

Key issues :	

The key issues relating to the project fall into four areas:

Applications and Business Models

In order to deliver broadband for all it will be necessary to identify appropriate customer oriented applications that can be delivered from HAPs.

Development of suitable business models will ensure that HAPs can economically deliver these applications and services. This is likely to involve customers in rural, suburban, and city centre areas.

Communications Links and Networking

Links will operate in the *mm*-wave bands, development of which is on the edge of current technology. It is important that the project influences the current ITU regulations governing HAP spectrum use - the 31/28GHz band has recently been made available in many countries around the world by the ITU WRC'03. Additionally, an accurate assessment of the propagation environment from HAPs is important, particularly for the high-speed broadband mobile application.

This mobile application lacks a suitable standard, and so it is vital for this application to be a success that the project identifies the most suitable standard and required modifications, preferably suggesting them to the appropriate standardisation bodies.

Radio resource management has been identified as particularly important – this not only controls the applications that can be delivered, but the final system capacity and ultimately revenue. This could be for single and/or multiple HAP constellations and novel spectrum sharing techniques are desirable. Activity in this area will take account of the regulatory environment and try to influence it where necessary.

Communications Nodes

A significant part of the project concerns the development of hardware for future communications nodes. Some of this will be to directly support the testbed, with significant activity responsible for developing critical elements to support the high-speed mobile train application, namely steerable/smart antenna technology. These developments may also be used on the HAP for antenna stabilisation and to create novel cellular structures.

Optical communications technology is being developed and will be tested as a backhaul link, as a way of supporting the high capacities required with a HAP architecture. A simulation-based study is examining the effect of HAP movement on the required pointing accuracy, and maximum supported link lengths obtainable from optical interplatform links. These results will govern the design future HAP architectures.

Testbed

Several key objectives of CAPANINA are concerned with testing the technology for fixed users. It is important that these tests are seen to deliver broadband from aerial platforms – success or failure is likely to have a long-term impact on aerial platforms as a technology. The tests will be carried out in a series of trials from several types of aerial platform over the three years of the project. In order to coordinate the different trial capabilities, these platforms will form a 'testbed' and will be supported by a common trial methodology. The trial vehicles, tethered aerostat, stratospheric balloon, and potentially HAP are not being developed as part of the project and are at the forefront of technology. Each trial will be scoped accordingly, so as to mitigate the risk of failure and make best use of each vehicle. Optical communications equipment will also be validated in the trials.

Expected impact :	

HAPs and other forms of aerial platforms have the potential to be a low-cost third alternative to terrestrial and satellite communications. Their low-cost delivery potential will be achieved through the high capacity (compared to satellite) that can be achieved from single/multiple platform(s) over a wide area (compared to terrestrial). This project will illustrate, through a series of practical tests and advanced investigations that aerial platforms can support such broadband users. It will provide significant innovation and forward-looking research into future generations of aerial platform broadband technology. HAP communications will be seamlessly integrated and allow interworking with existing systems. The opportunities provided by the HAP communications systems will generate new demand for multimedia services, e.g. telemedicine.

This technology will bring about a revolution in communications delivery, providing high capacity, low cost, value added networked services. It will help bridge the digital divide by allowing service provision to 'currently excluded' citizens, marginalised by:

- **Geography** - Today geography plays a major part in whether a service can be made available to a user. Low user densities (e.g. in rural areas) and/or large distances from established infrastructure mean cost effective solutions are not available, resulting in a significant minority of Europe's citizens being disadvantaged. This new technology, with its wide-area coverage at potentially low cost, will remove the geographical constraints.
- **Low-cost, low-volume requirements** – SMEs, home workers, agricultural workers, etc. are currently saddled with high costs and/or low data rates. This technology removes the need to discriminate against such users, as low-cost terminal equipment will ensure an equitable share of the bandwidth to all user types.
- **Travelling on high-speed public transport vehicles** – Such users are currently badly served. The available data rates on trains are low and often delivered by 2G mobile technologies. Even with 3G mobile, data rates will be restricted to, at best, a few hundred kbit/s. This project intends to deliver WLAN rates to users on public transport, allowing them to share in the same available data rates as portable users accessing fixed WLAN hotspots in the local café/bar/public building. In fact the data rate will be constrained by the WLAN technology and not by the link to the HAP. Broadband to vehicles of all types allows for new vehicular applications such as CCTV inside train carriages allowing remote monitoring for security reasons. Advanced fleet management and traffic control will also be possible, allowing rapid downloading and communication with on-board computers.

Consortium Partners :

Partner No.	Partner Name	Partner short name	Country
1	University of York/York Electronics Centre	UOY/YEC	UK
1	University of York/Department of Electronics	UOY/DOE	UK
3	Jozef Stefan Institute	JSI	Slovenia
4	CERCOM/Dipartimento di Elettronica - Politecnico di Torino	POLITO	Italy
5	EuroConcepts s.r.l	EUCON	Italy
6	Universitat Politecnica Catalunya/Department.TSC	UPC	Spain
7	Carlo Gavazzi Space S.p.A.	CGS	Italy
8	Budapest University of Technology and Economics	BUTE	Hungary
9	Btexact Technologies	BT	UK
10	Deutsches Zentrum für Luft- und Raumfahrt e.V.	DLR	Germany
11	SkyLINC Ltd	SKYLINC	UK
12	Centre Suisse d'Electronique et de Microtechnique SA	CSEM	Switzerland
13	Contraves Space AG	CSAG	Switzerland
	"Third" Country Associated Participant		
14	Communications Research Laboratory	CRL	Japan