

# Ultra Scalable Switch Prototype

IP-FLOW European Project {EC Contract No. 002807}

## Overview

### IP-FLOW (IP - FLoWs over Optical and Wireless)

IP-FLOW (IP FLoWs over Optical and Wireless) is a European project supported by Marie Curie Chair (EXC) Actions. The focus of IP-FLOW project is on the flow control of IP packet over the Internet. Timing and flow control are critical since they directly affect how users perceive the quality of IP-based services, such as, voice-over-IP, video-over-IP, multimedia content delivery etc.

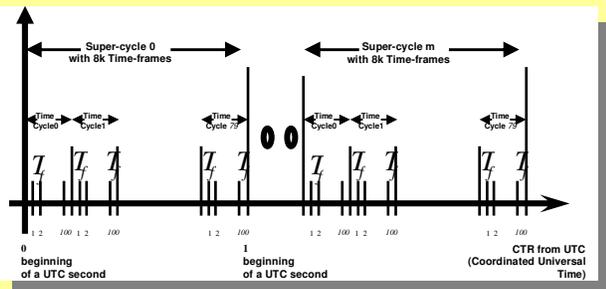
#### Main Features

- **Deterministic** service guarantee for streaming media applications
- **Scalable** solution (minimum switching and buffering complexity)
- **Low cost** by using primarily off-the-shelf components and UTC **freely** available from GPS/Galileo

## Main Issues

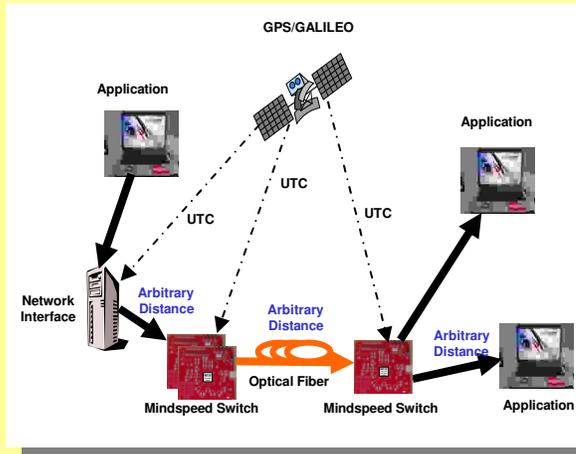
- **Switch bottleneck:** Coordinated universal time (UTC, available from GPS and Galileo) is used with pipeline forwarding for solving the **switch bottleneck** problem – specifically, Implementation of a multi-terabit (e.g., 40 terabit) switch in a single chassis.
- **Link bottleneck:** UTC with pipeline forwarding is used for solving the bandwidth mismatch problem between optical and wireless network, which is a **link bottleneck** problem.

Proper solutions of the above two bottleneck problems are critical for ensuring proper network operation and users' satisfaction, and consequently, improving the IP networks services and business perspective.



- UTC from GPS/GALILEO is the reference super cycle of one second.
- Each super cycle is divided into a number of time cycles.
- Each time cycle is divided into a number of time frames.

## Ultra Scalable Switch Prototype



The switch architecture guarantees deterministic QoS and is scalable to 40 Terabit per second and beyond. In order to achieve such performance pipeline forwarding of IP packets is used. Pipeline forwarding is a method known to provide optimal performance independent of specific implementation. Invented by Henry Ford, pipeline forwarding is still the most efficient manufacturing process today. All computers today operate using pipelines, a simple extension of Ford's assembly line. This project demonstrates pipeline forwarding over the Internet. The necessary condition for such pipeline forwarding is global time - UTC, e.g., from GPS/Galileo.

The results of this activity demonstrate how pipeline forwarding can solve the electronic switching bottleneck while optimizing physical space – specifically, packaging a 40Tb/s (terabit per second) switch in a single chassis. The switching granularity of the presented device ranges from 1Mbps (megabit per second) to a full channel capacity of 10Gb/s (gigabit per second), and can be deployed from the core to the edges of the network.

## Scalability Features

- Topology: lowest complexity - Banyan interconnection network:  $N \log N$  switching elements (N is the number of inputs)
- Buffer: minimum buffer requirement (for only one time frame)
- Control: predefined and simple switching schedule used periodically
- Speed up: optimal speedup of one for switching and memory access
- No real-time packet-by-packet header decoding and scheduling
- Switching schedule changed on long time scale

## Partners

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