

Towards the Future Internet

A Survey of Challenges and Solutions in Research and Standardization

Internet Protocol Version 6 (IPv6)

RFC 2460

■ Features of IPv6

- Simple header for **efficient** processing
- Sufficient **number of addresses** -> better distribution for efficient routing
- Flow Label** for easy flow identification -> **Quality of Service**
- Built-in security: **IPsec** is mandatory

■ Challenges for Upper Layers:

- Support for IPv6 and IPv4 (**dual-stack**) -> Migration Path
- Handling of multiple addresses -> **Multi-Homing**
- Handling of **prefix changes** -> Mobility

■ Deployment:

- Supported by all major operating systems
- Usable via **tunnelling** over IPv4, some providers already provide it directly!

Migration from
IPv4 to IPv6

Flow Routing

Work in Progress

■ Key Assumption of Classical Internet Routing:

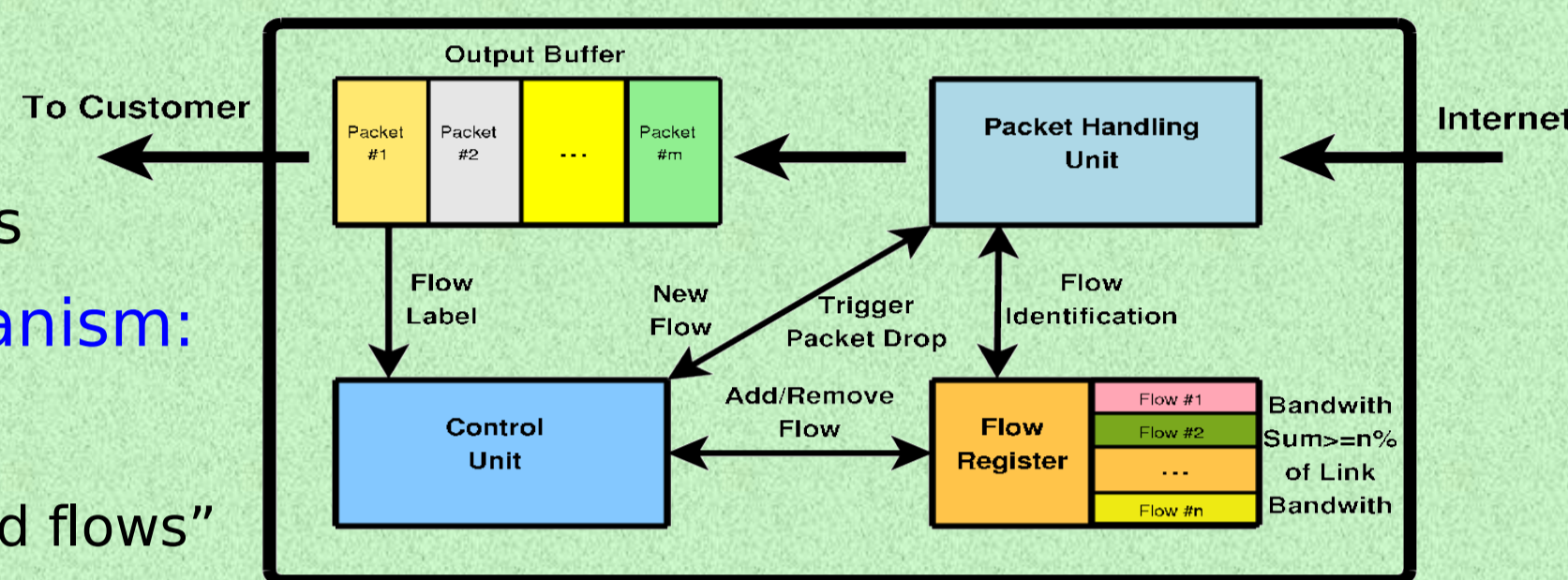
- Router memory is scarce and expensive => **Stateless Packet Routing**
- ... but recent hardware is **powerful** and memory **inexpensive**!

■ New Approach: Flow Routing!

- Per-flow state for routing
- May be used for QoS mechanisms

■ Our Idea for a Simple QoS Mechanism:

- Overload handling procedure:
 - Focus packet discard on "selected flows"
 - Full quality for all other flows!
- Application:** Delivery of **multimedia** content to **broadband customers** (e.g. DSL)



Network Layer

Stream Control Transmission Protocol (SCTP)

RFC 2960

■ Features of the SCTP Transport Protocol:

- Reliable**
- Connection-oriented**
- Message-oriented**
- Security:**
 - 4-way handshake
 - Immune against flooding attacks

■ Path Redundancy by Multi-Homing

- 1 association, n paths
- Still works if up to $n-1$ paths break
- Path monitoring by heartbeats
- Fine-granular configuration
- Per-association congestion control

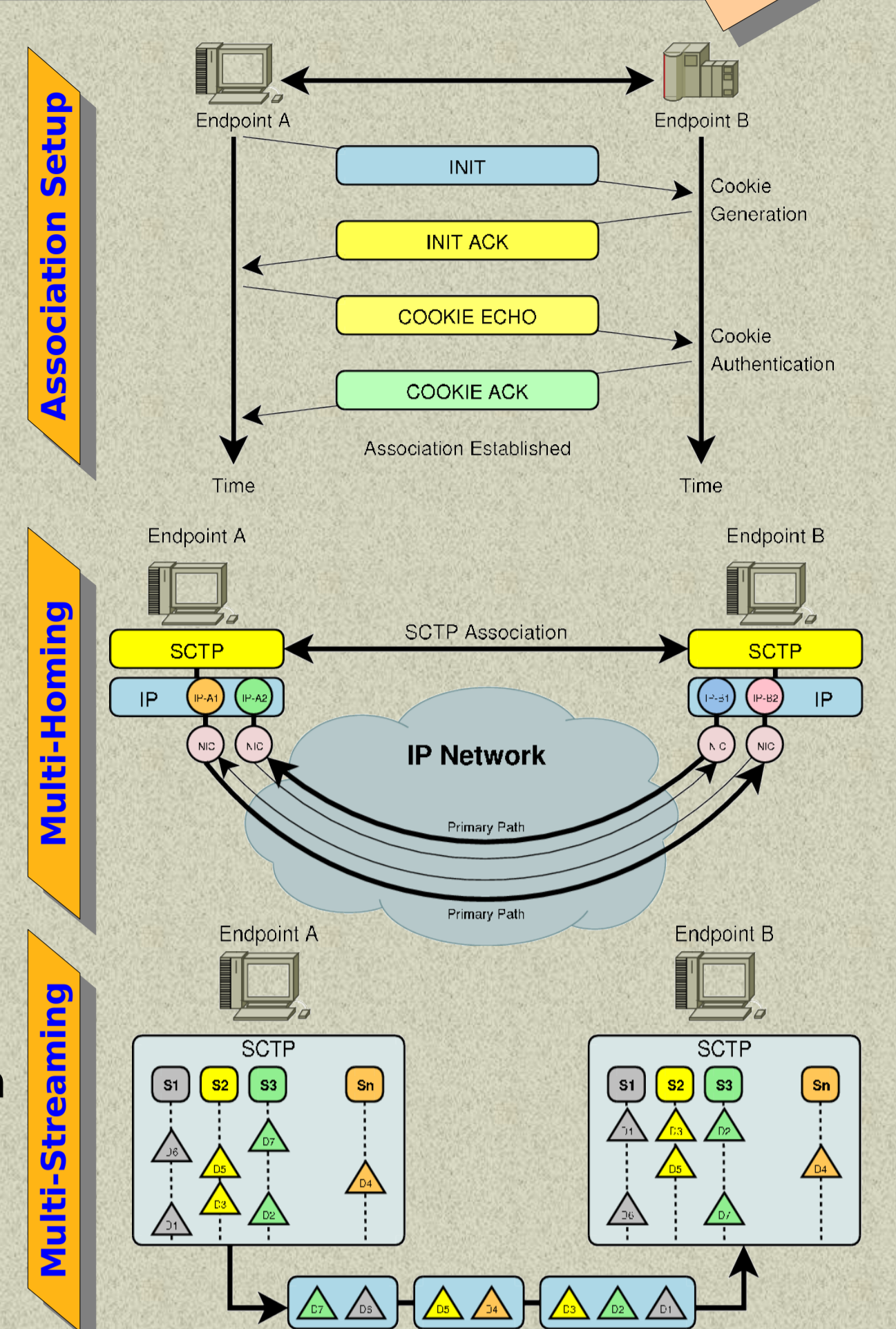
■ Multi-Streaming

- Up to 65,536 streams via single association
- Useful e.g. for VoIP/multimedia trunks
- No head-of-line blocking**

■ Optional Extensions

- Add-IP** – Add/remove network addresses during association runtime
 - Support for IPv6 prefix changes
 - Upgrade IPv4-only -> IPv4/IPv6 -> IPv6 only – without interrupting associations!
 - Support for mobile endpoints
- PR-SCTP** – Timeout for retransmission (similar to UDP, but with congestion control!)
- Secure-SCTP** – Built-in per-stream/per-message encryption and authentication

■ Deployment: SCTP is available for all major operating systems now!



The Future Internet

Session Layer

Reliable Server Pooling

The IETF's first
Session Layer standard!!

■ A Generic, Application-Independent Framework for

- Server pool management and
- Session handling

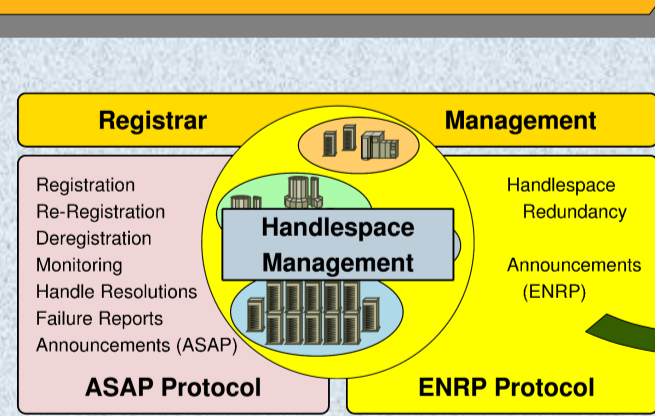
■ Key Features

- Lightweight
- Real-Time
- Scalable
- Extendable
- Simple

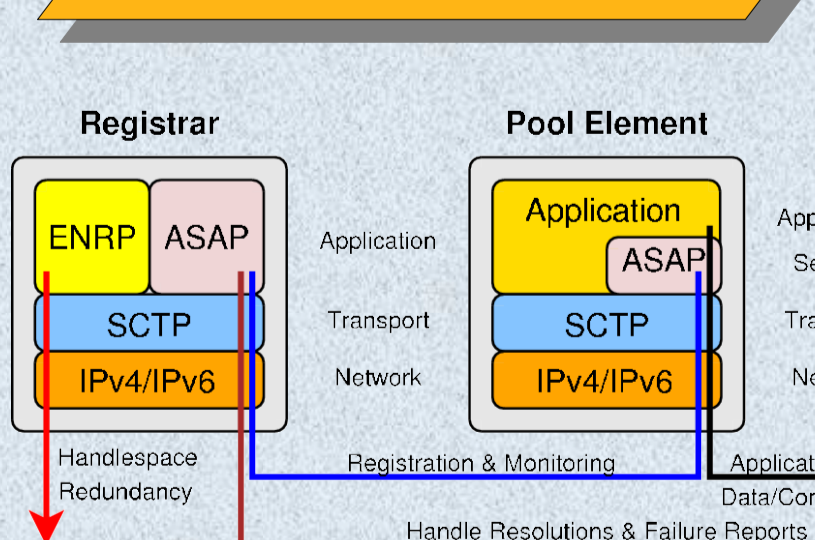
■ Under Standardization by the IETF

- Reference implementation** developed by us!
- RFCs coming soon!

Architecture



Protocol Stack



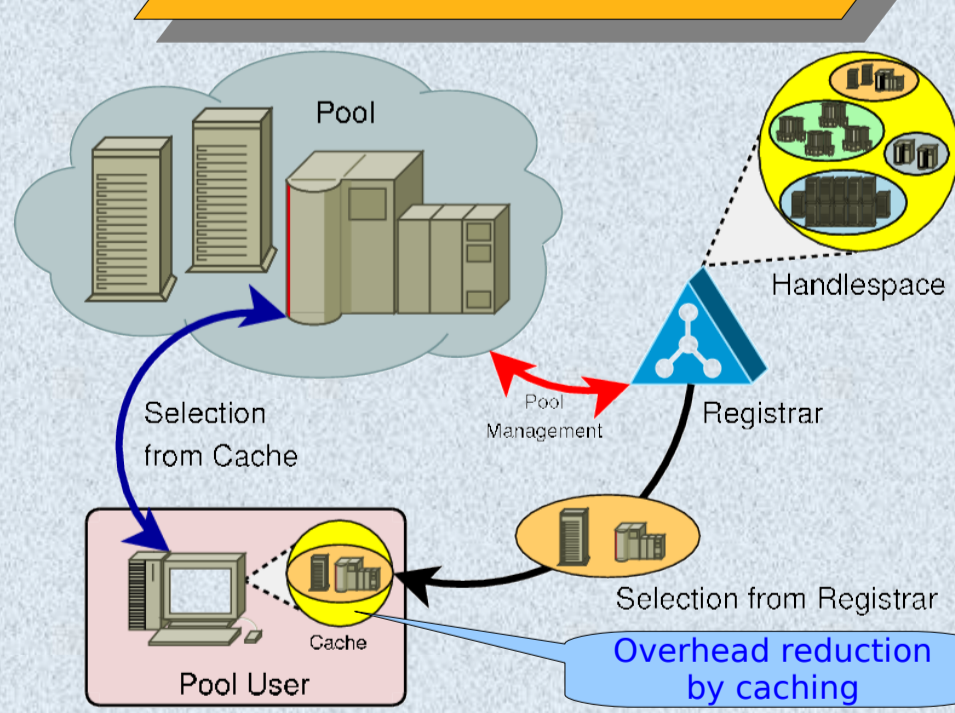
RSerPool Terminology

- Pool Element (PE):** Server
- PE ID:** Unique ID of PE
- Pool Handle:** Unique ID of pool
- Set of pools**
- Registrar (PR):** Pool management
- Pool User (PU):** Client

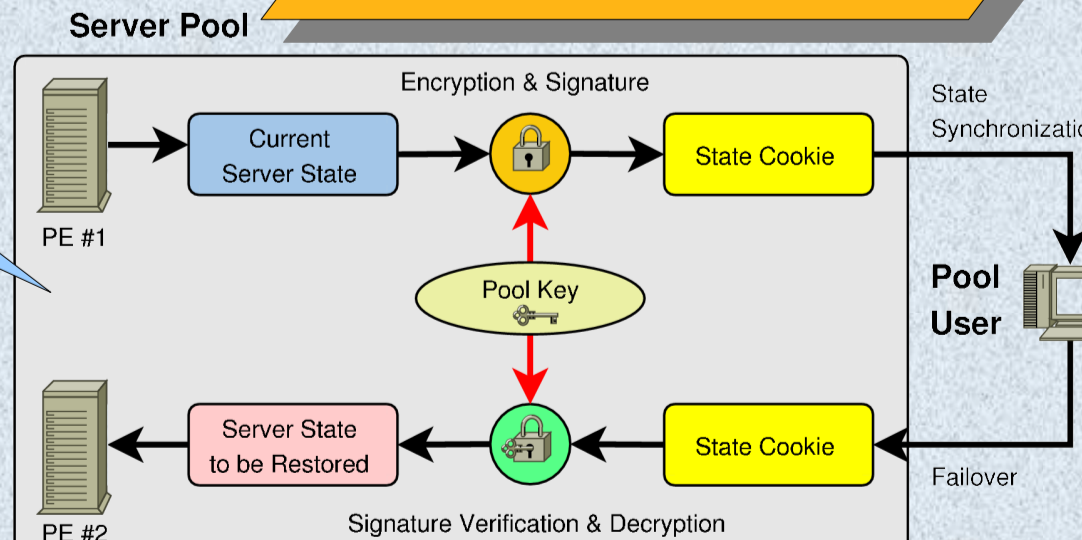
RSerPool Protocols

- ASAP** (Aggregate Server Access Protocol)
- ENRP** (Endpoint Handlespace Redundancy Protocol)

Server Selection



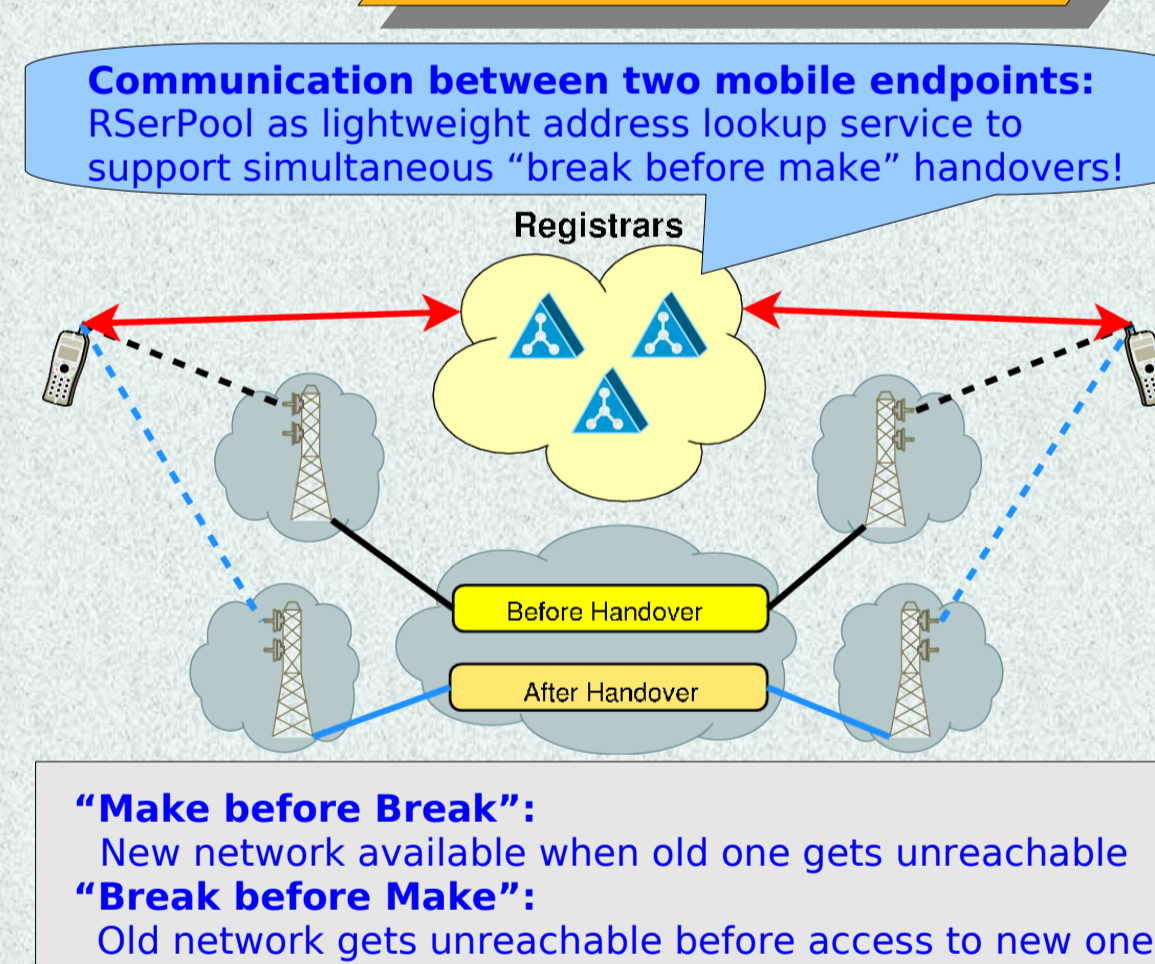
Fallover Support



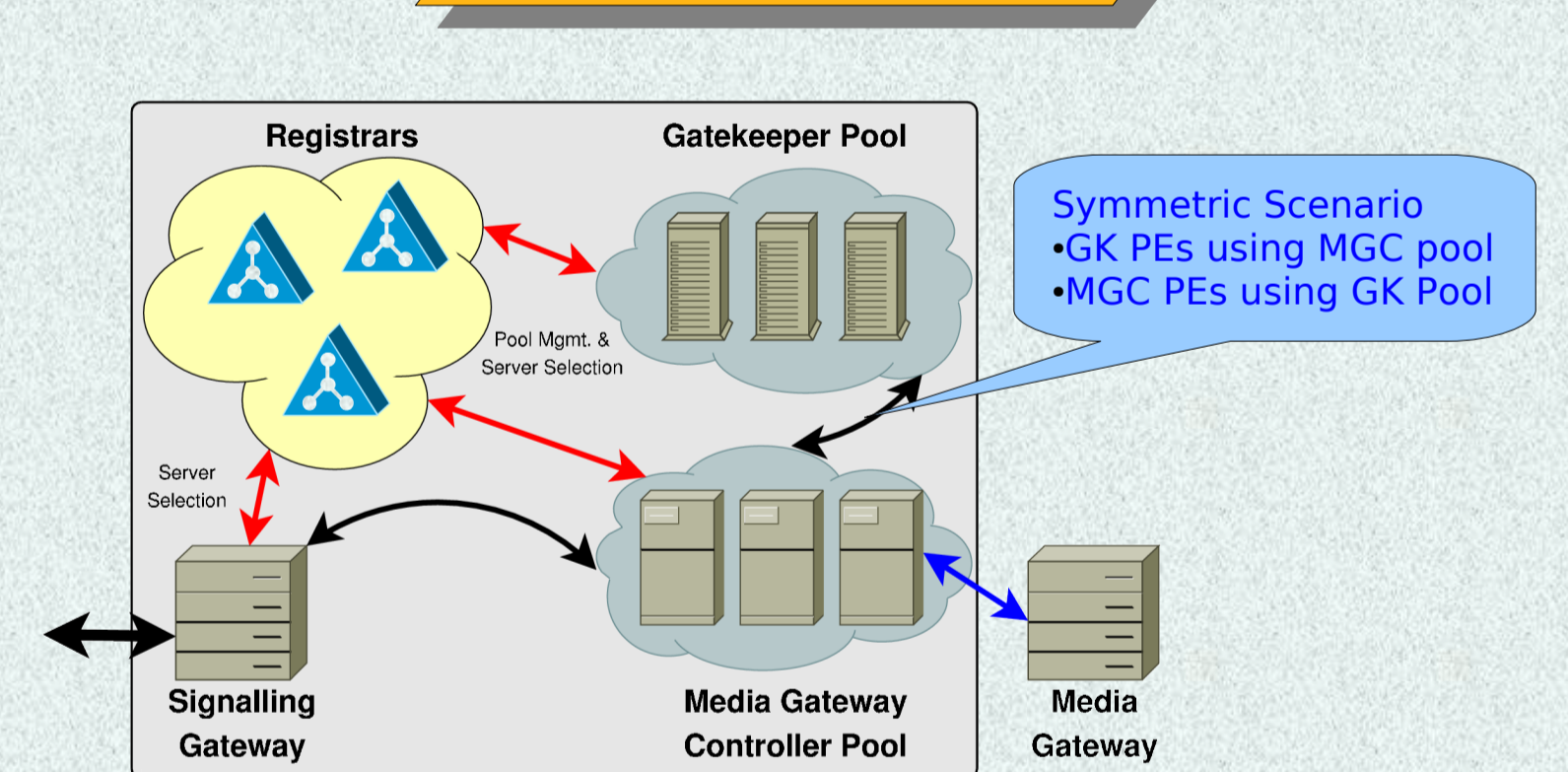
Services using Reliable Server Pooling

Work in Progress

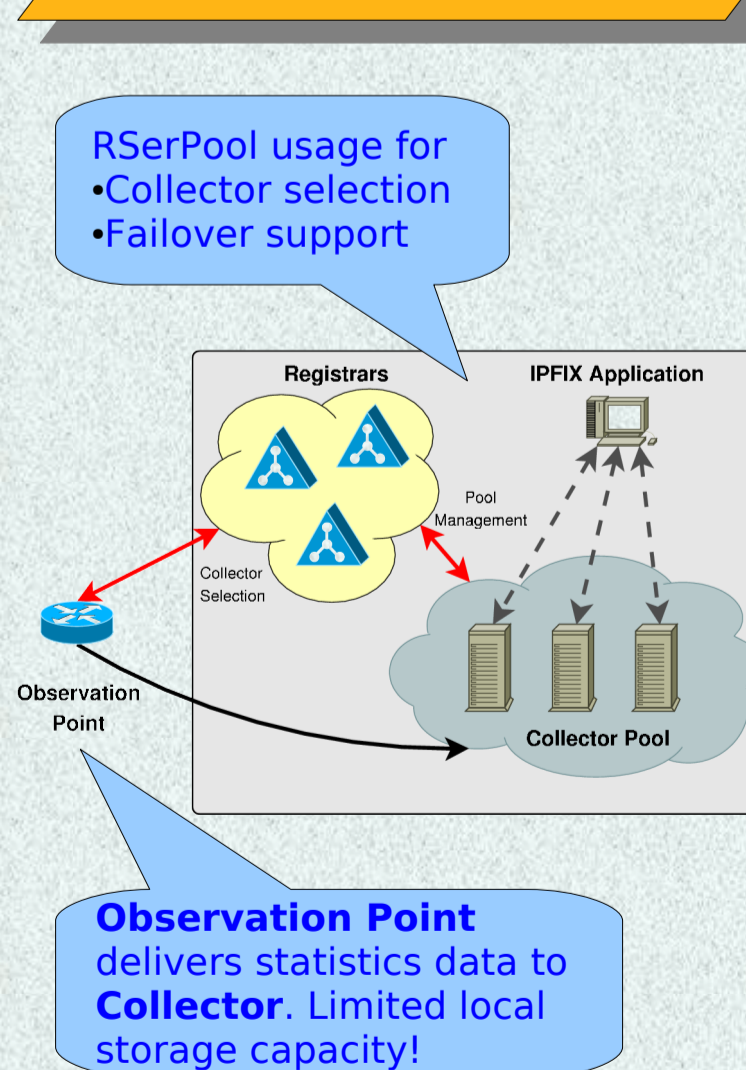
SCTP-based Mobility



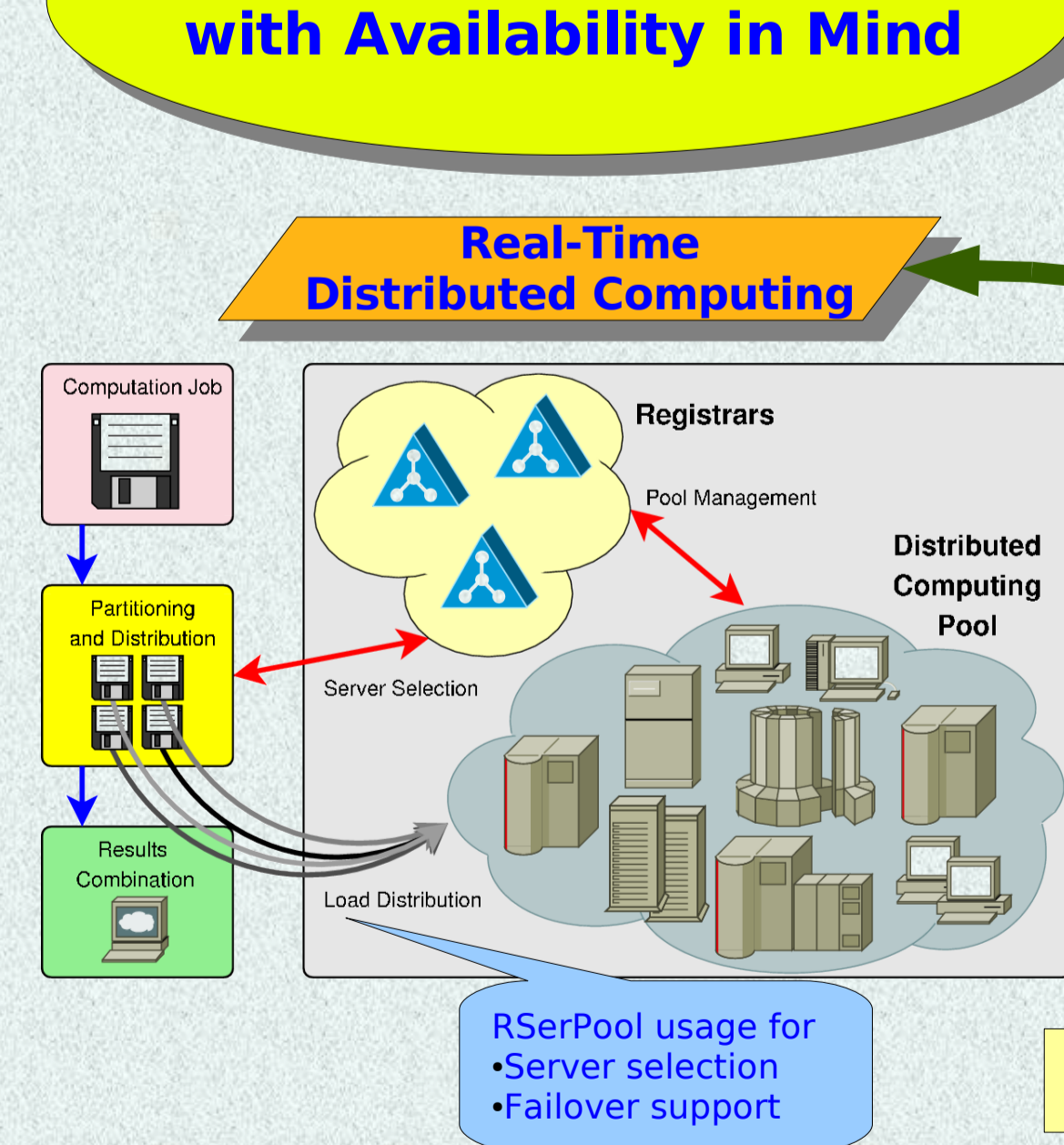
SS7 and VoIP



IPFIX



Application Development with Availability in Mind



Battlefield Networks

Web Server Pools

Load Balancers

...

A Proof of Concept:
Our RSerPool prototype demo system

Our Contributions



University of Duisburg-Essen

Flow Routing

- Research**
 - Novel approach for a simple QoS mechanism for real-time multimedia content delivery to broadband customers
- Contributions to Standardization**
 - IETF (Flow Identification)
 - ITU-T (QoS Signalling)

SCTP

- Open Source Prototype Implementation SCTPLIB**
- Evaluation, Optimization and Improvement**
 - Path management of multi-homed associations
 - Security
- Contribution of Results into IETF Standardization**
 - Secure-SCTP extension (Individual Submission)
 - RFC 3436 (TLS over SCTP)

Reliable Server Pooling

- Open Source Prototype Implementation RSPLIB**
- Evaluation, Optimization and Improvement**
- Various Contributions to Major IEEE Conferences**
- Contribution of Results into IETF Standardization**
 - 4 Working Group Drafts
 - 6 Individual Submissions