The Internet Routing Overlay Network (IRON)

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Emerging Internet Architecture Issues

- **Routing Scaling:**
  - Internet DFZ routers require full routing tables
  - Doesn't scale well with multihoming; PI
- **IPv4 Address Depletion:**
  - Internet needs to support unlimited addressing
  - Near-term result: NATs
  - Desired end state: IPv6
- **Mobility Management:**
  - Mobility not well integrated with Internet routing and addressing
  - Can use stable mobility anchor points that track mobile nodes, but leads to sub-optimal routing

Internet Architecture Issues (2)

- **Multihoming:**
  - Difficult for EUNs to use single IP prefix via multiple providers
  - How to choose best provider for cost/performance?
  - (Key issue for aircraft with multiple data links)
- **Traffic Engineering:**
  - How to best spread outbound traffic over multiple providers
  - Even more difficult in the reverse direction – how can the network know which provider to use to get to the EUN?
- **Provider Independence:**
  - EUNs should be able to use their same IP addresses wherever they connect to the network
  - E.g., laptop users should be able to take their laptops overseas and still be reachable by their same IP address

The Internet Routing Overlay Network (IRON) – RFC6179

- **Based on RANGER**
  - **(RFC5720, RFC6139)**
- **Descended from ISATAP**
  - **(RFC5214, RFC4214)**
- **VET NBMA Tunnel Virtual Interface Model**
  - **(RFC5558; draft-templin-intarea-vet)**
- **SEAL Generic Tunneling Encapsulation Format**
  - **(RFC5320; draft-templin-intarea-seal)**

IRON Overview

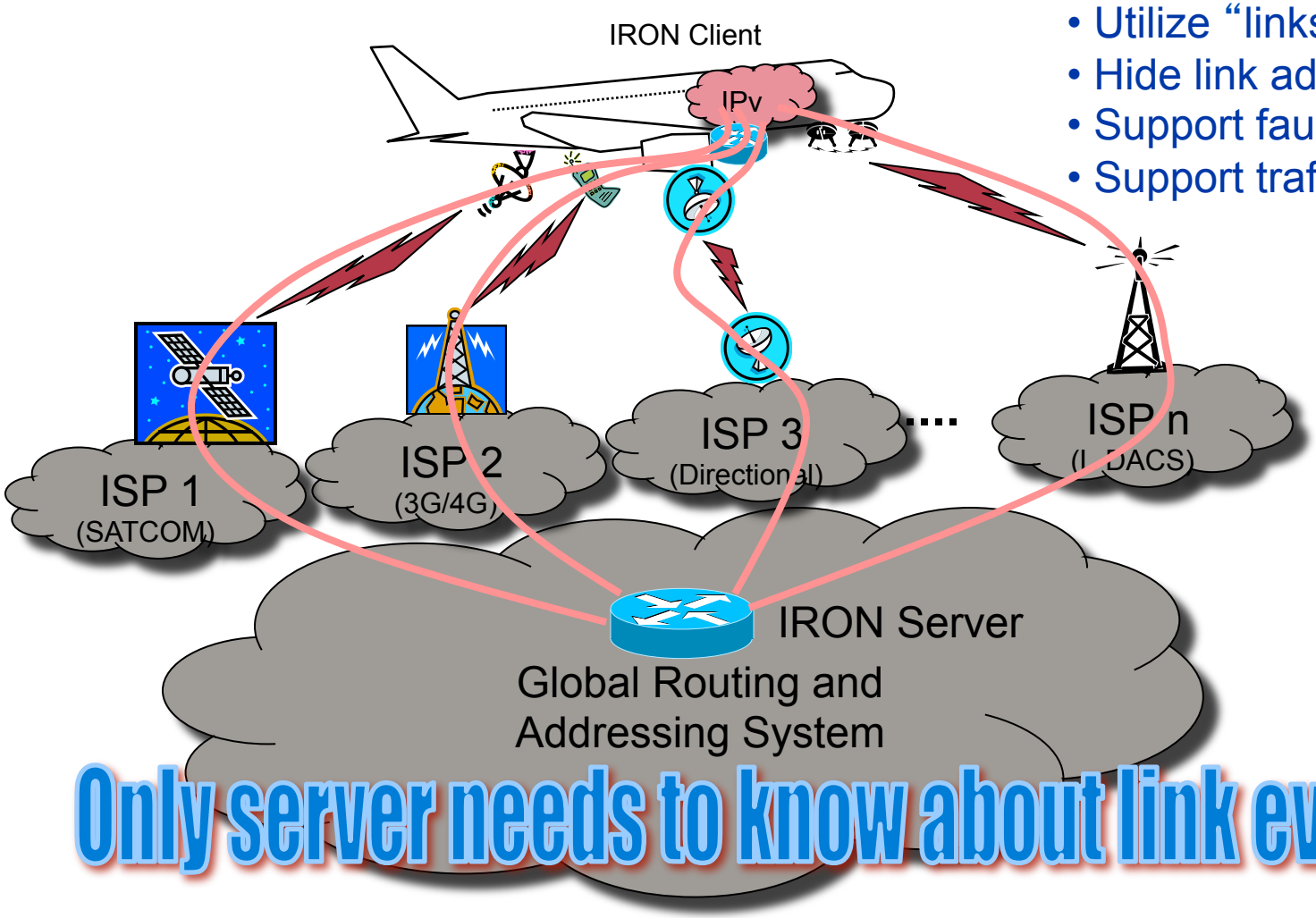
- **Overlay network routing and addressing system**
  - **Virtual Prefixes (VPs) advertised in DFZ (e.g., 2001:F00::/24)**
  - **End-User Prefixes (EPs) go to customers (e.g., 2001:F00::/56)**
- **Overlay network goals**
  - **Incremental deployment - no changes to existing Internetworks**
  - **Multi-protocol environments cleanly supported (IPv6, IPv4, OSI, …)**
  - **Mobility management naturally supported**
  - **NAT traversal naturally supported**
  - **End User Networks (EUNs) get stable IP addresses**
  - **Routing scaling is unaffected due to mobility or multihoming**
  - **Multihoming and multiple interface support (e.g., 3G/4G, WiFi, WiMAX, DOCSIS, etc.)**
- **Hybrid proactive / on-demand routing system:**
  - **Native Internetwork routing for shortest paths btw gateways**
  - **Route optimization through secure network redirection**

IRON Functional Elements

- **IRON client**
  - connects End User Networks (EUNS)
  - selects an IRON server as default router
  - tunnels packets to server nearest the destination
  - accepts packets only from its own server
- **IRON server**
  - globally distributed throughout the Internet
  - serve as client anchor points
  - forward outbound packets toward IRON relay router anycast
  - proxy any control messages (e.g., Redirects) back to clients
- **IRON relay**
  - connects the IRON to the rest of the Internet
  - hub for redirection process
  - full topology of client-to-server mappings

IRON Client to Server Registrations

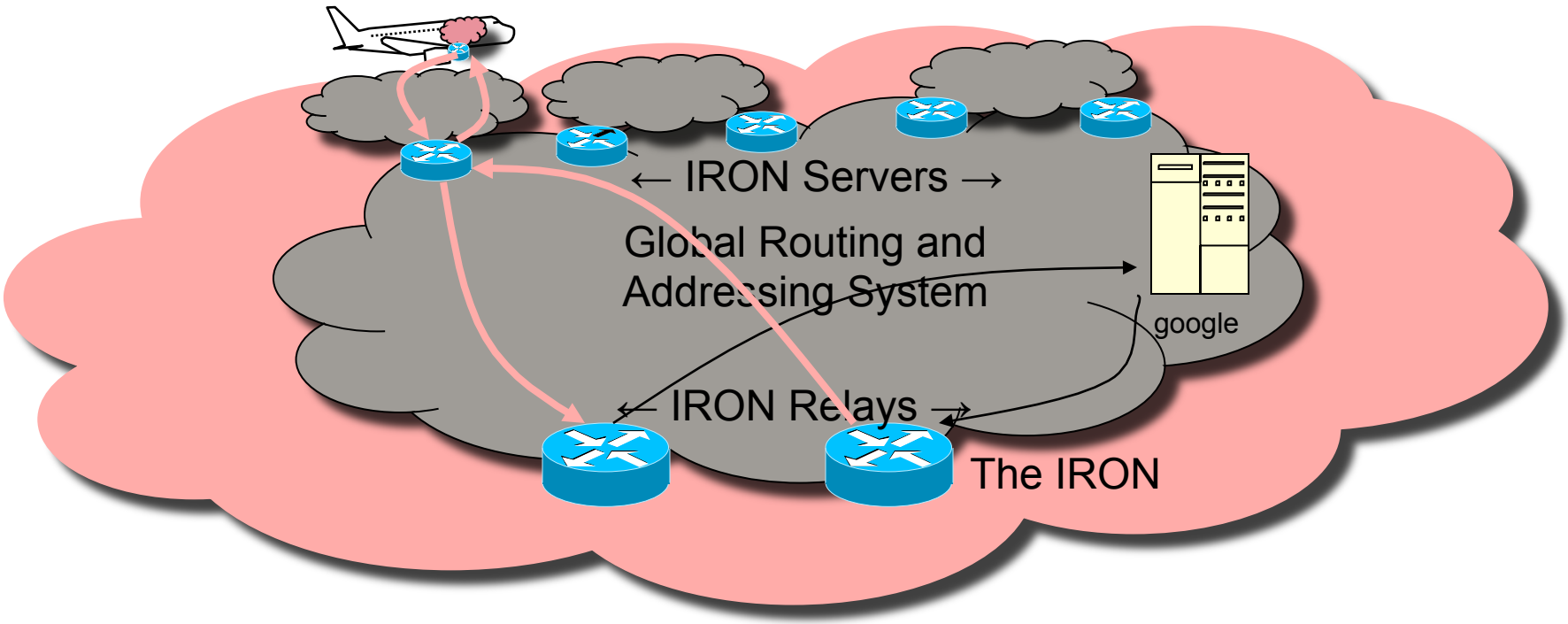
- Harness all available links
- Utilize "links of opportunity"
- Hide link address changes
- Support fault tolerance
- Support traffic engineering



Only server needs to know about link events

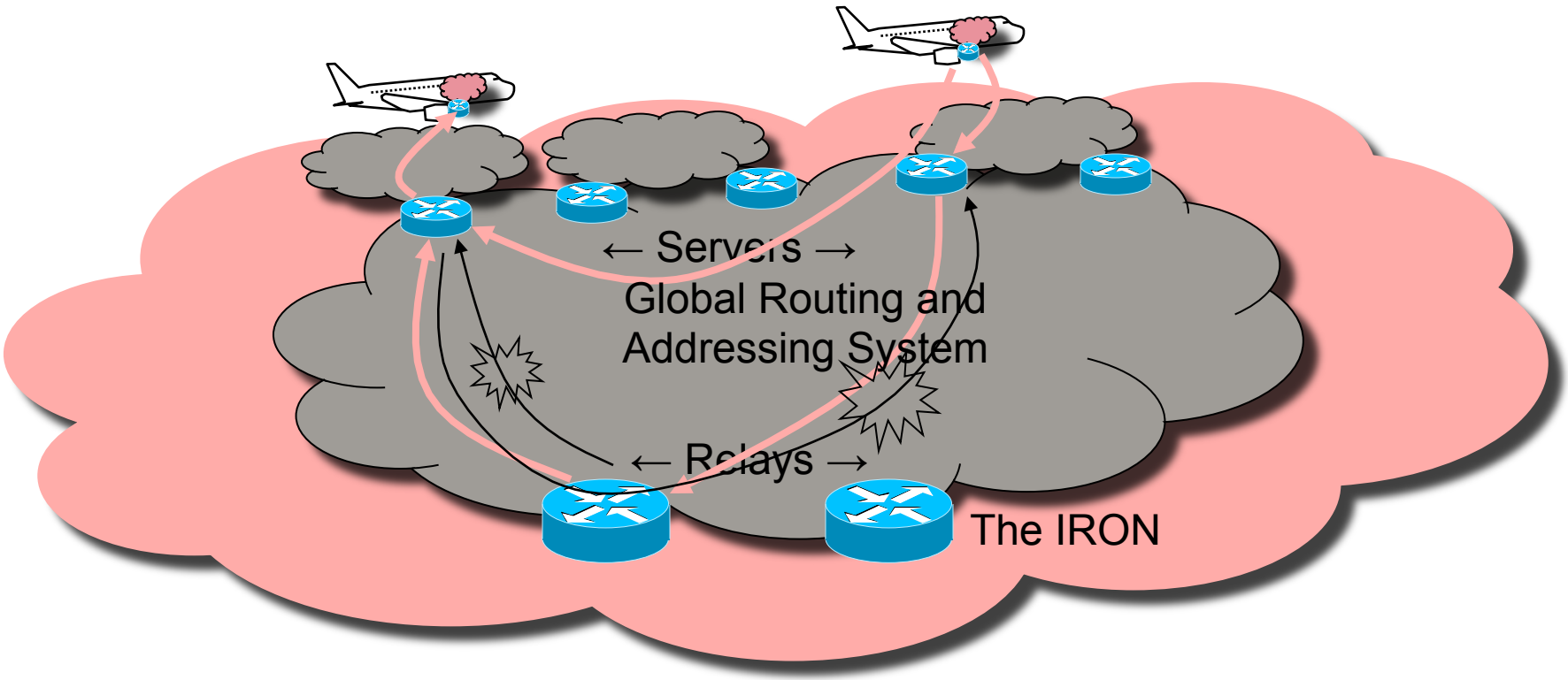
Client Connecting to Internet-based Correspondent

- Client associates all of its links with server
- Client discovers new servers as it moves or if current server fails
- Relays connect IRON-based Clients to non-IRON Correspondents



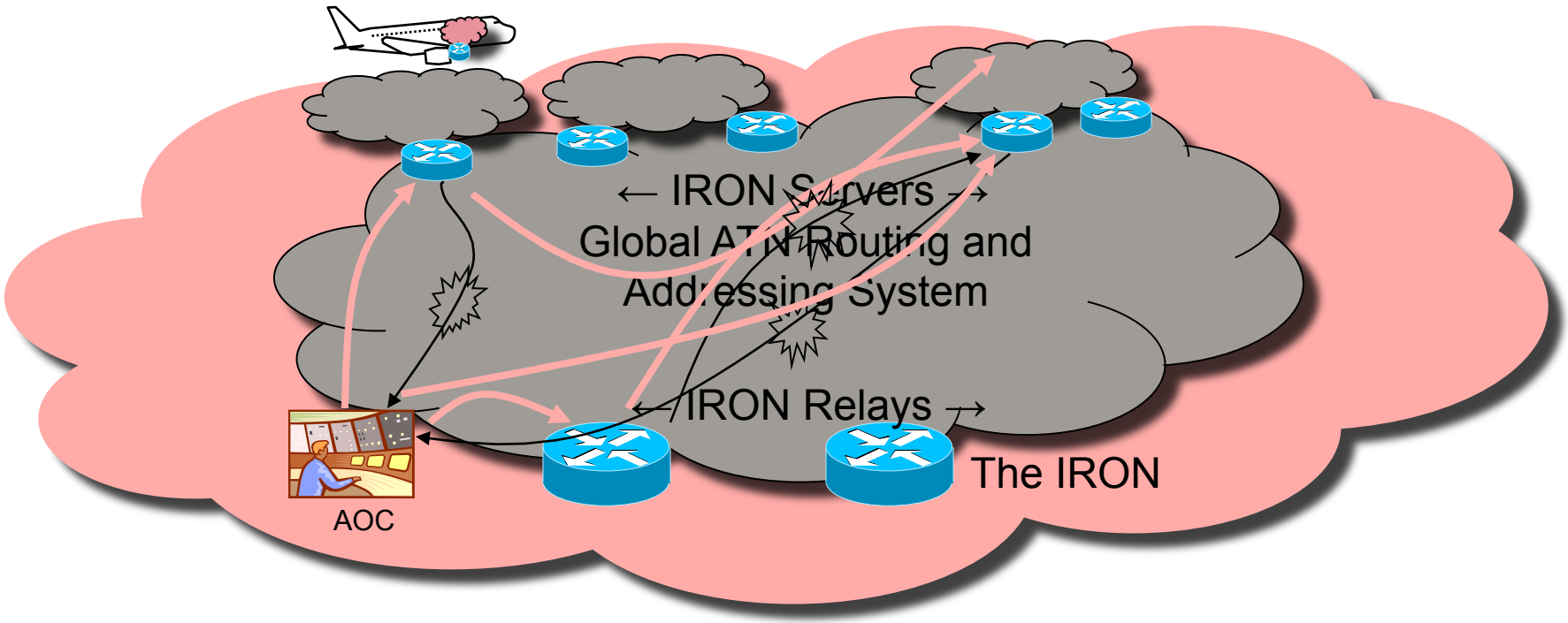
Client Connecting to IRON-based Correspondent

- Clients both associate with their respective Servers
- Relays only handle the initial packets in a flow
- Relays send predirects *forward*, and proxy redirects back
- Subsequent packets go directly without involving relays



Client Moving to New Server

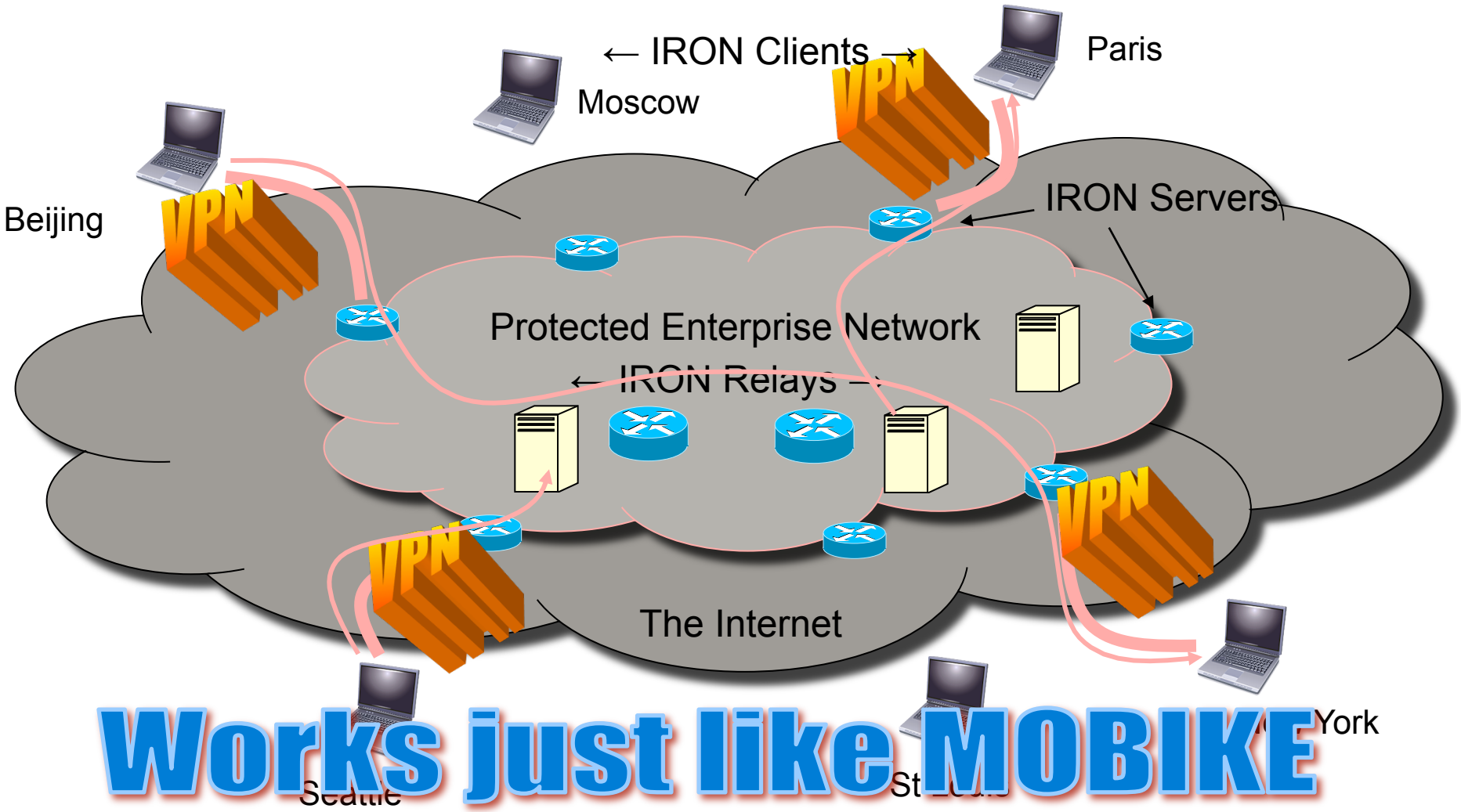
- Client moves to new close-by Servers as it travels
- Old server schedules forwarding state for expiration; still forwards packets to last known address of client
- Old server sends cancellations to correspondents
- Correspondents go back to relays and get re-redirected



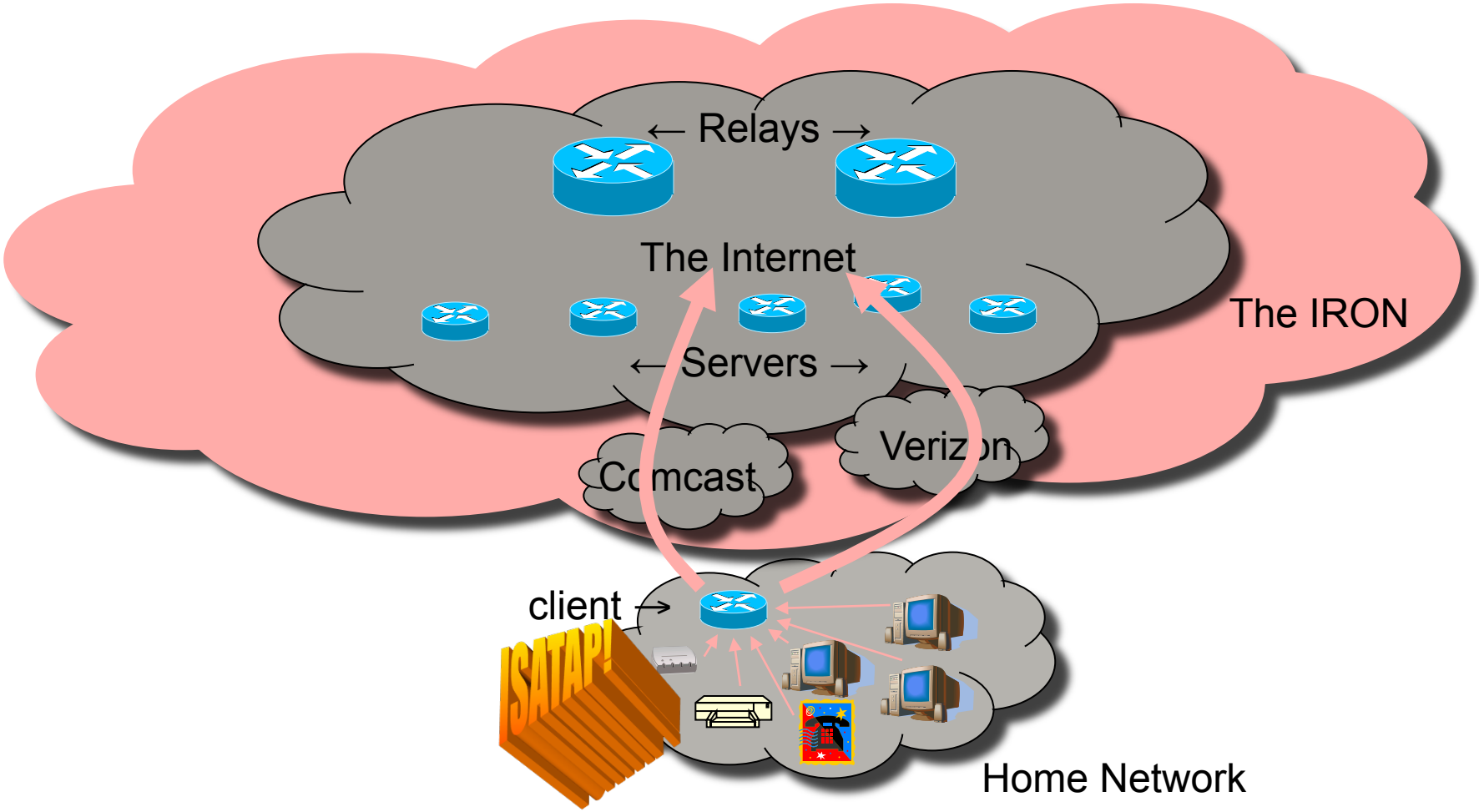
Mobility Summary

- Client represents its links to Server
  - inbound packets always come though Server:
    - NAT traversal
    - multiple interface support
    - accommodate link address changes
  - outbound packets go to Server nearest correspondent
  - Client moves to new Server only if it moves far from old, or if old Server fails
- Server discovers link address changes (time-critical)
- Relay tracks Client/Server bindings (non-time-critical)
- Strict correspondent binding updates not necessary
- Correspondents only told that the mobile node has moved:
  - Old server still delivers packets in-flight to the mobile node
  - Correspondent deletes old route and discovers new route

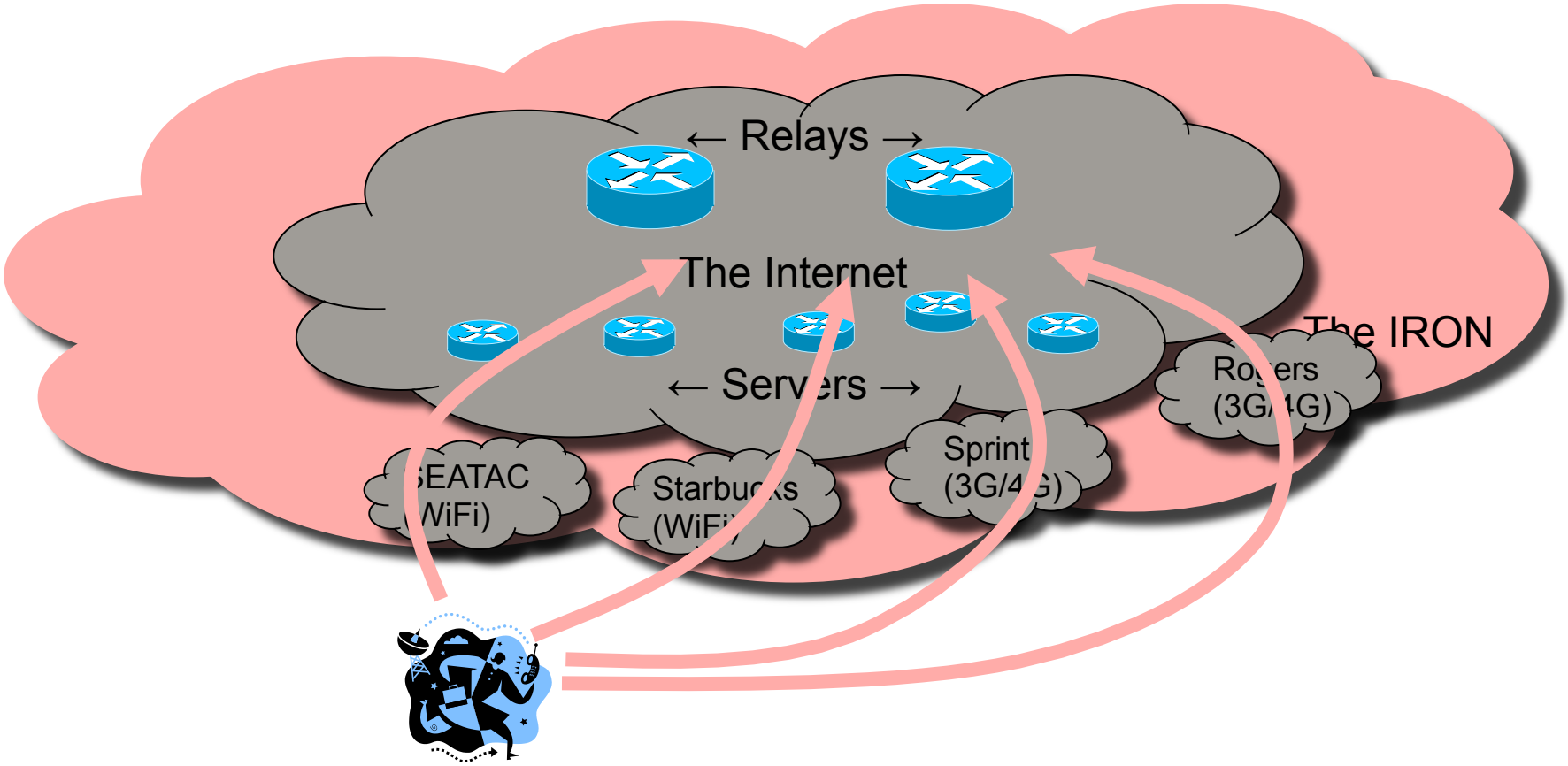
Security Architecture: Mobile Enterprise Network Clients



Additional Use Case: Home Networks



Additional Use Case: Multi-Access Cellular Telephony



Multi-Access Cellular User

BACKUPS

Implementation

- **Current implementation is linux kernel network driver plus linux controlling application**
- **Leverages existing Linux Simple Internet Transition (sit) and L2TP network drivers**
- **Data plane in kernel; control plane (mostly) in userland**
- **Uses IPv4/UDP/SEAL/IPv6 encapsulation (UDP for NAT traversal and ECMP striping)**
- **SEAL Control Message Protocol (SCMP) for router discovery, neighbor discovery, route optimization through secure redirects**

IETF Publications

- **The Internet Routing Overlay Network (IRON)**
  http://tools.ietf.org/html/rfc6179
- **RANGER Scenarios (RANGERS)**
  http://tools.ietf.org/html/rfc6139
- **Routing and Addressing in Networks with Global Enterprise Recursion (RANGER)**
  http://tools.ietf.org/html/rfc5720
- **Virtual Enterprise Traversal (VET)**
  http://tools.ietf.org/html/draft-templin-intarea-vet
  http://tools.ietf.org/html/rfc5558
- **Subnetwork Encapsulation & Adaptation Layer (SEAL)**
  http://tools.ietf.org/html/draft-templin-intarea-seal
  http://tools.ietf.org/html/rfc5320
- **ISATAP**
  http://tools.ietf.org/html/rfc5214
  http://tools.ietf.org/html/rfc4214