

Realizing Mobility-as-a-Service (MAS) over CCN

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Agenda

- Mobility-as-a-Service
- ICN Network Architecture
- Mobility Service Control/Forwarding Plane
- Interest/Data Processing
- Producer Mobility Handling
- Test Setup and Results
- Other Proposals
- Conclusions



Mobility as a Service Requirements

- **Realize mobility as a network service that can be enabled or disabled**
 - With sufficient flexibility in the network architecture this can be achieved
 - Also In 5G, mobility can be service per application slice
- **Enable mobility as a service for applications**
 - Name based networking allows that, as services can explicitly seek mobility service for a name.
- **Routing Stability**
 - Avoid Routing instability and churn due to end point mobility.
- **Scalability**
 - Both Intra- and Inter- domain scalability
 - Considering IoT devices for example.
- **Name Persistence**
 - Application shouldn't require any name reconfiguration due to mobility

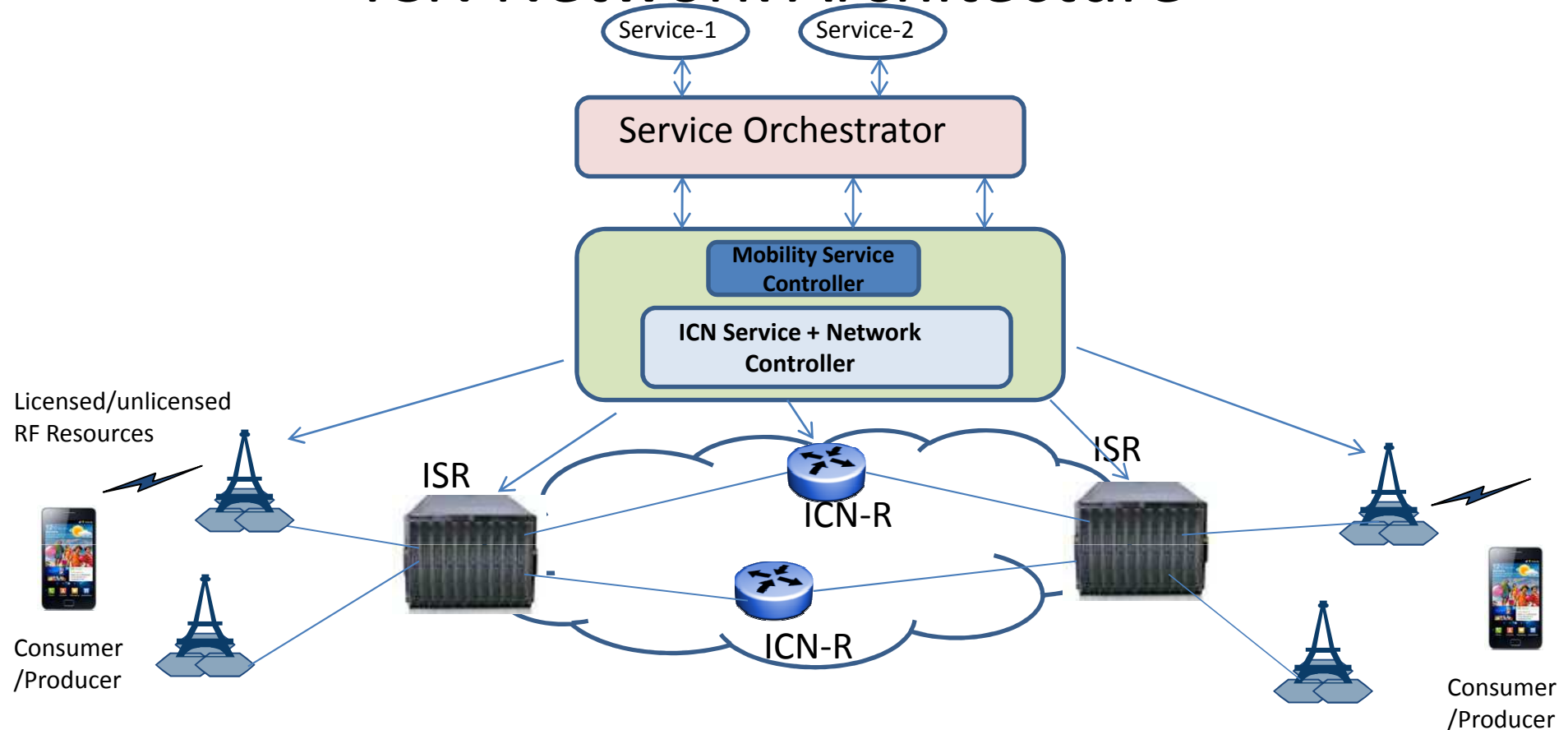


ICN Network Architecture

- Many ICN architectures build on splitting ID and Locators e.g. MobilityFirst, NetInf etc.
- Introduces separation between ID and Locator Names in CCN.
 - Forwarding-label draft : <https://tools.ietf.org/html/draft-ravi-ccn-forwarding-label-01>
- Separation has many use cases, mobility is only one of them.
 - Others include opportunistic routing, edge service affinity, in-network computing etc.
- Forwarding-labels are carried as a fixed optional header
- Network manages the mapping between the two name spaces
 - Doesn't preclude the case of application using it e.g. towards Manifests.
- This is enabled through incremental enhancement over CCN to provide richer services in the network edge.

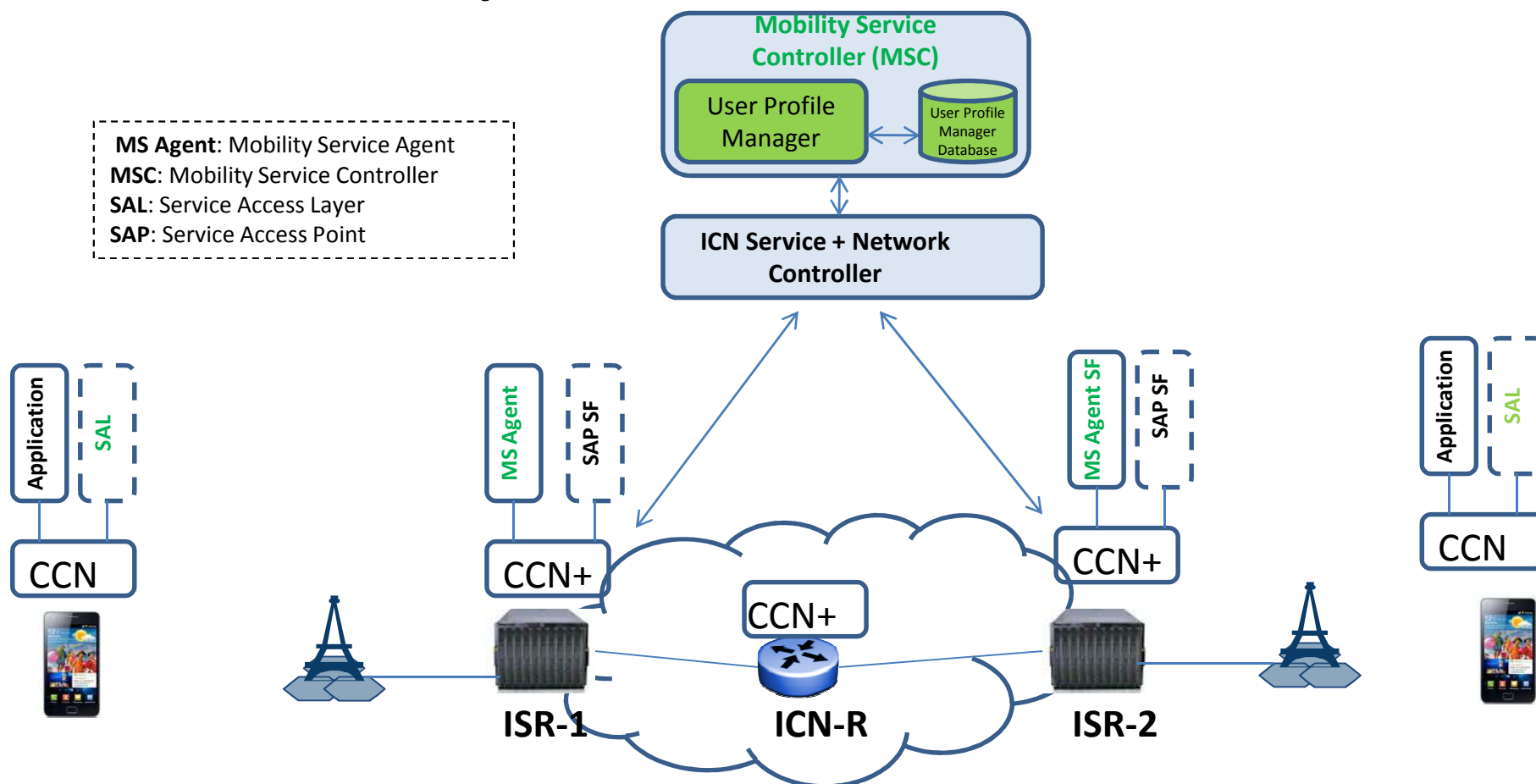


ICN Network Architecture



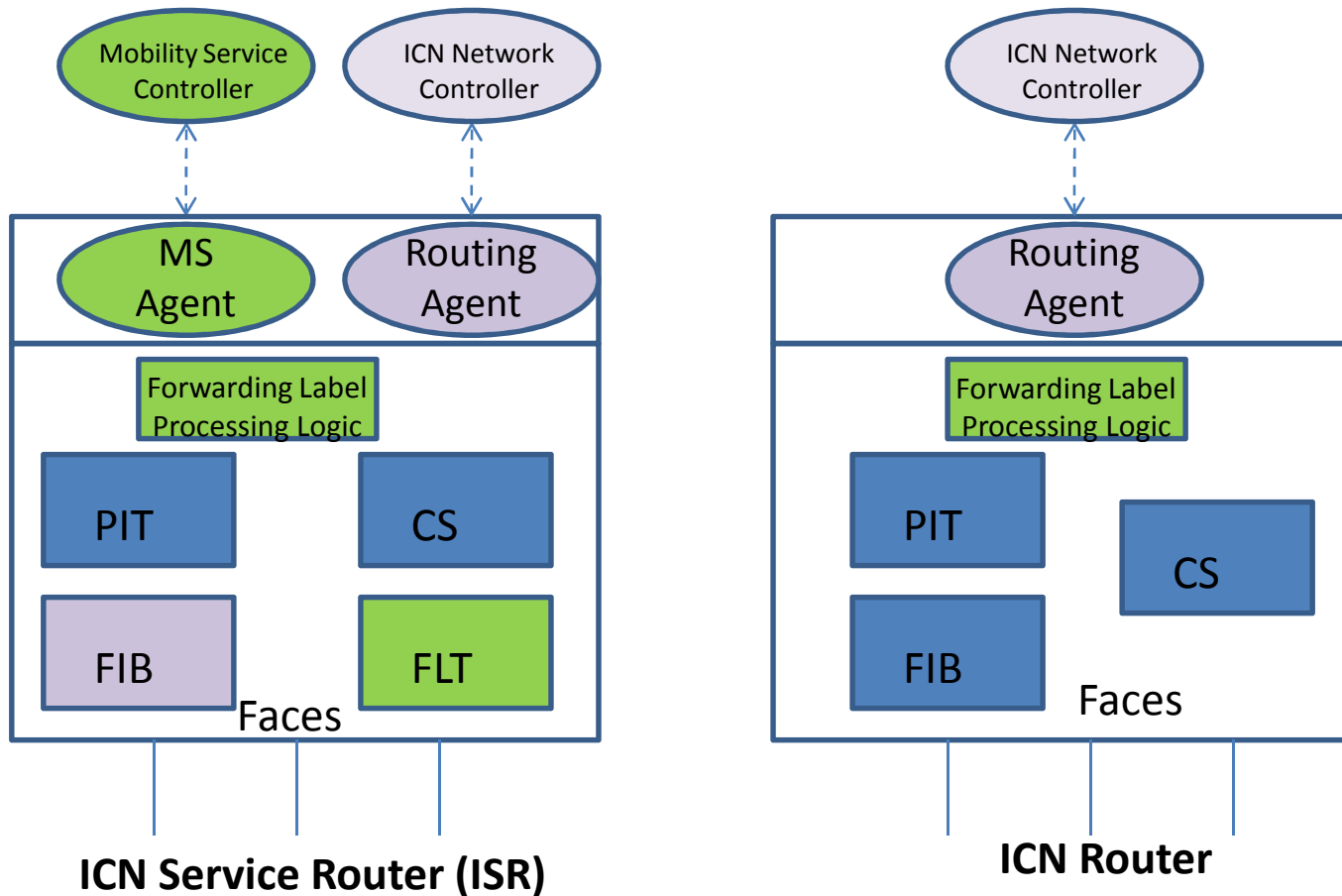
- **ISRs** are CCN Service Routers, where service functions can be plugged in to aid several edge services.
 - Mobility is one such service function
- **ICN-R** are CCN Relay Routers
- **ICN Service Controller** manages ICN Service Functions which can be plugged in any ISR nodes.
- **ICN Network Controller** allows dynamic provisioning of CCN FIBs based on Service Requirements.
- **Mobility Service Controller** manages the user profiles and the names to the locator name mapping.
- This can also be realized within a transport capable of creating ICN slice.

Mobility Service Control Plane



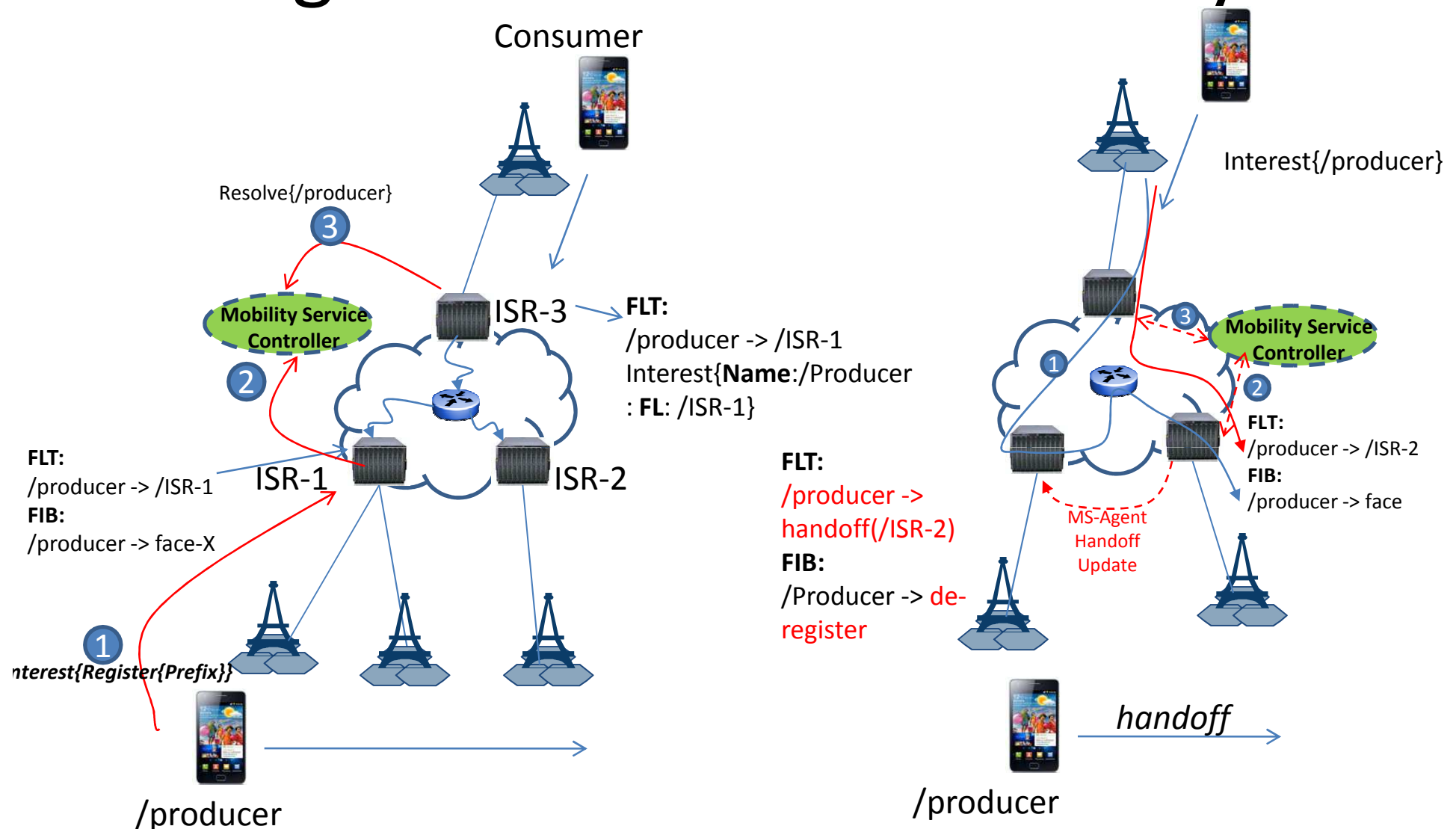
- **MS Agent** is a MS specific SF orchestrated by the Mobility Service Controller.
 - Registration/De-Registration of Service Names which require mobility.
 - Resolves Interest Names to locators through the MSC.
- **MSC** establishes a full meshed routing for the locator names, e.g. /isr-x
- **User Profile Manager** maps Services and the Names for which mobility is being handled
- **SAL/SAP** are control plane functions aiding ISR and MobilityService discovery.
- **SAL** also handles Mobility Service Signaling on behalf of the Application.

ICN Data Plane



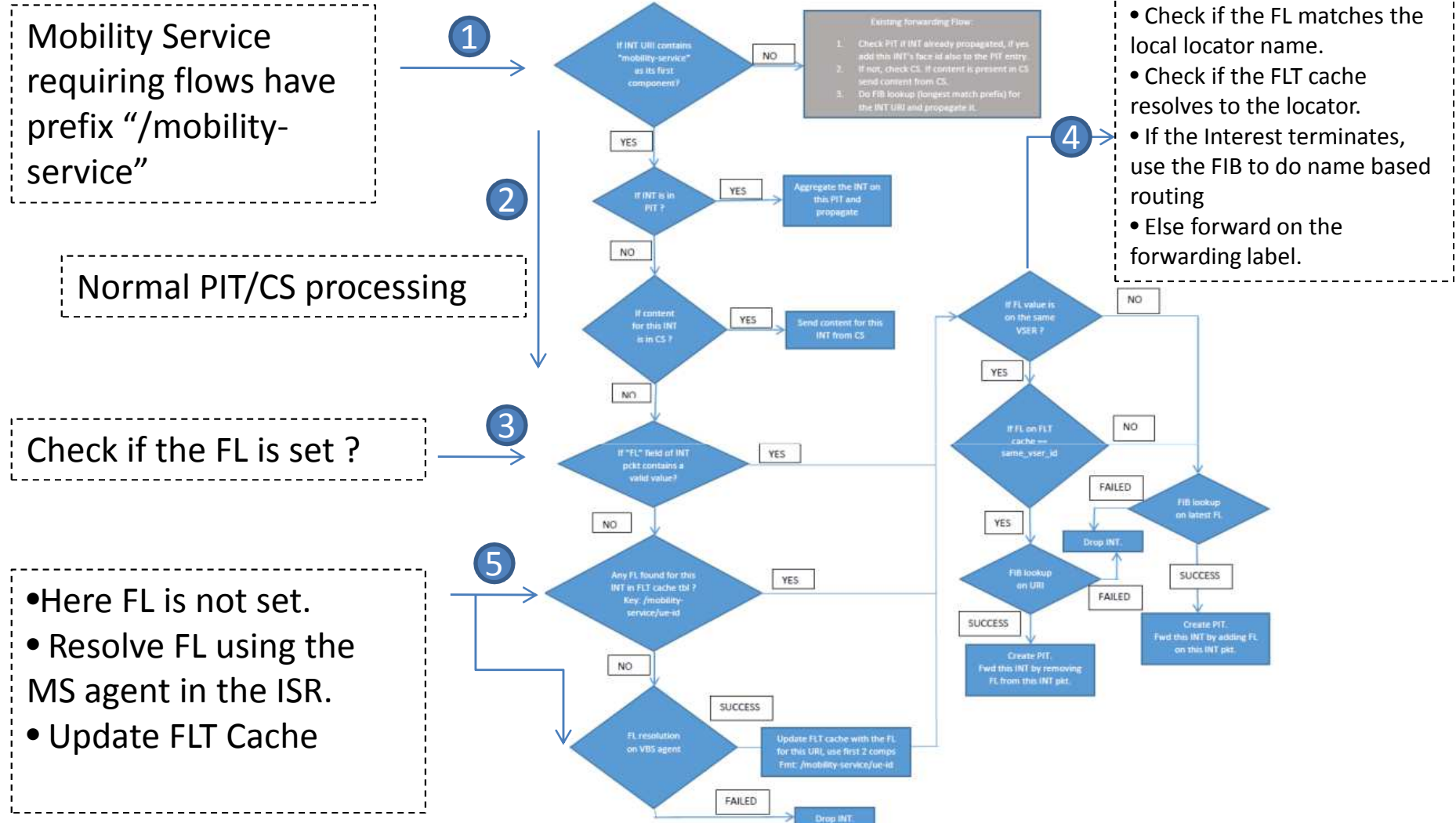
- **The mobility state is limited to the edges**, i.e. in the ICN Service Router .
- We introduce a new **Forwarding-Label Cache Table** , which keeps mapping of the name to the locator name mapping.
- The ISR applies LPM to match Interests to the FLT state.
- Local MS Agent is used to resolve names to locators through the mobility service controller.

High Level Producer Mobility



- Seamless mobility is handled by the ISRs in the edges.
- The returned Content Objects are marked, triggering update by the ingress ISR.

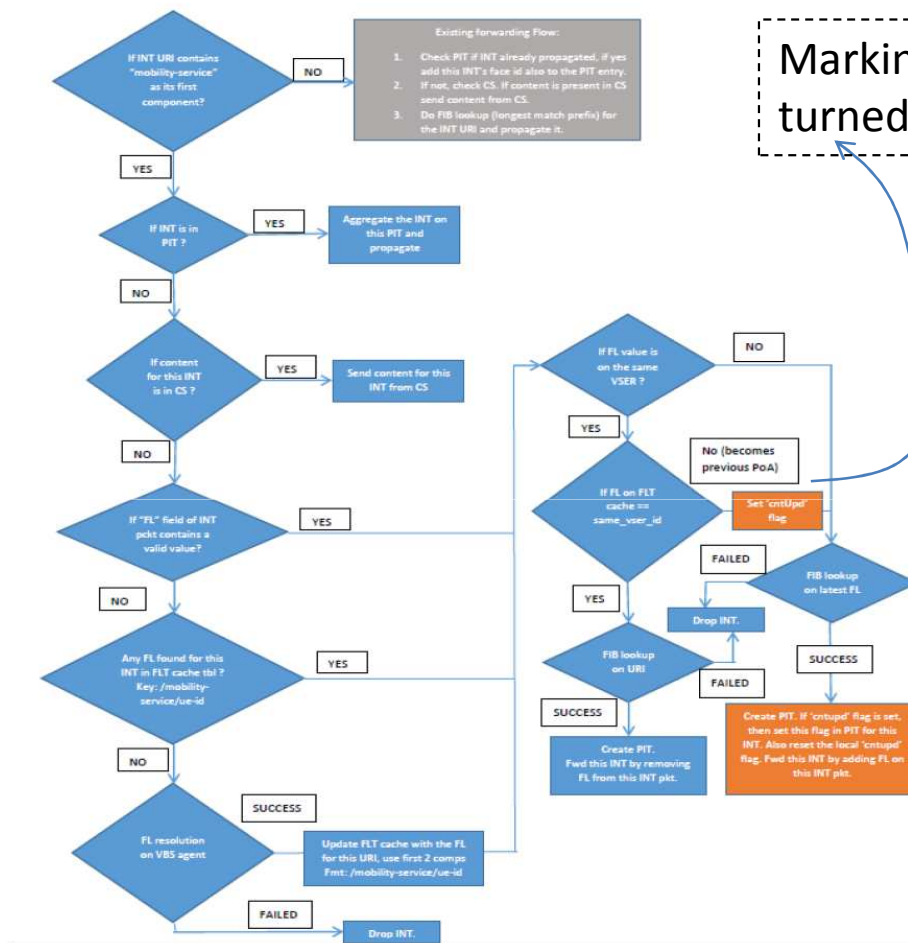
Interest Processing



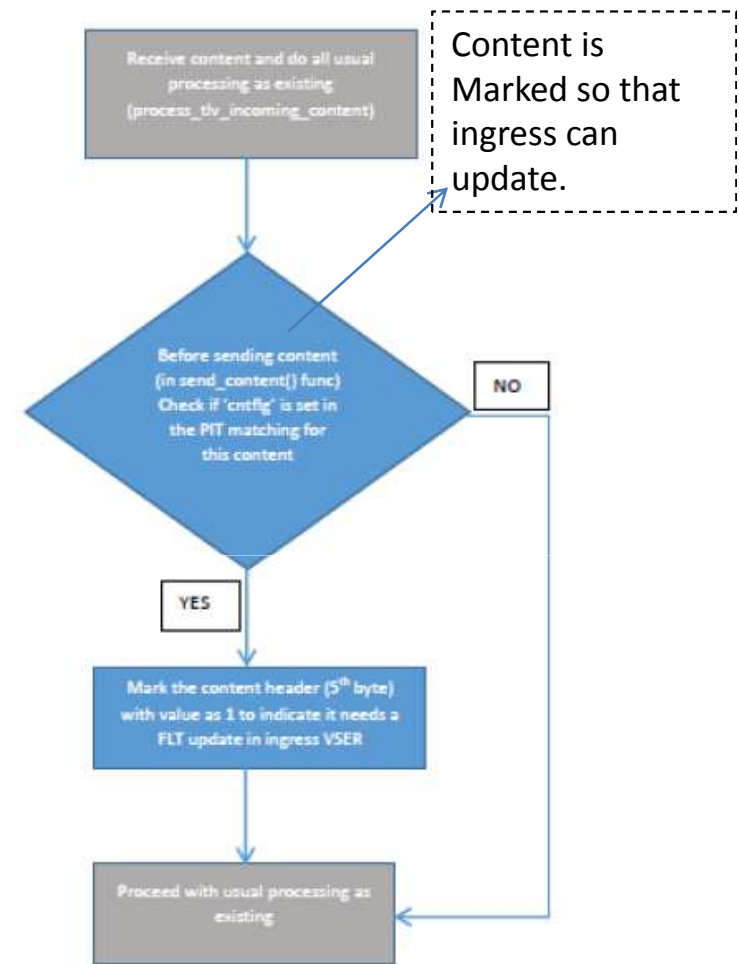
- Flows can be identified using any other metadata in the Interest payload.
- FL are swapped based on the FLT policies



Seamless Mobility Handling Details



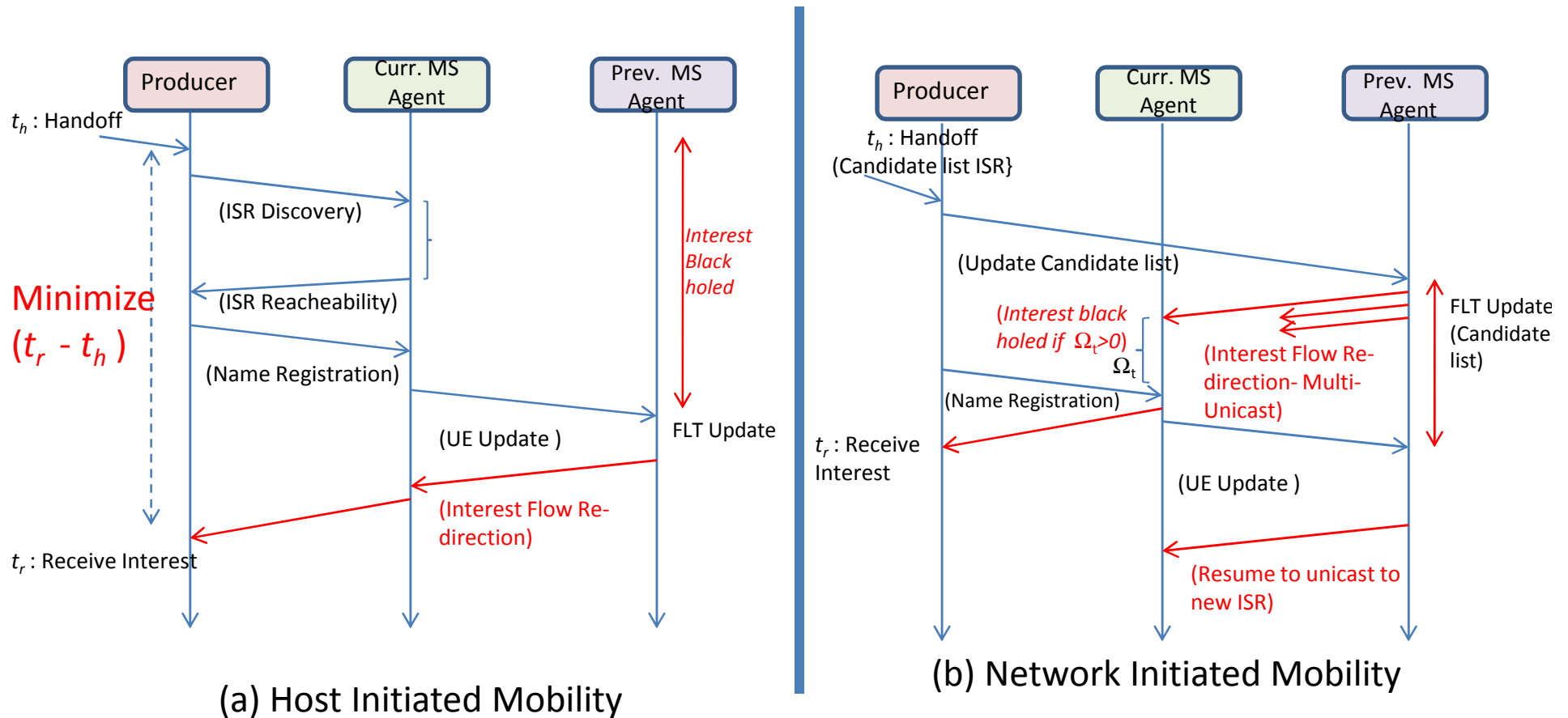
→ Deals with MS-Agent Updates from new PoA to the previous one, and Interest Re-direction



→ Deals with Content Object Marking and Ingress ISR FLT Cache Update.



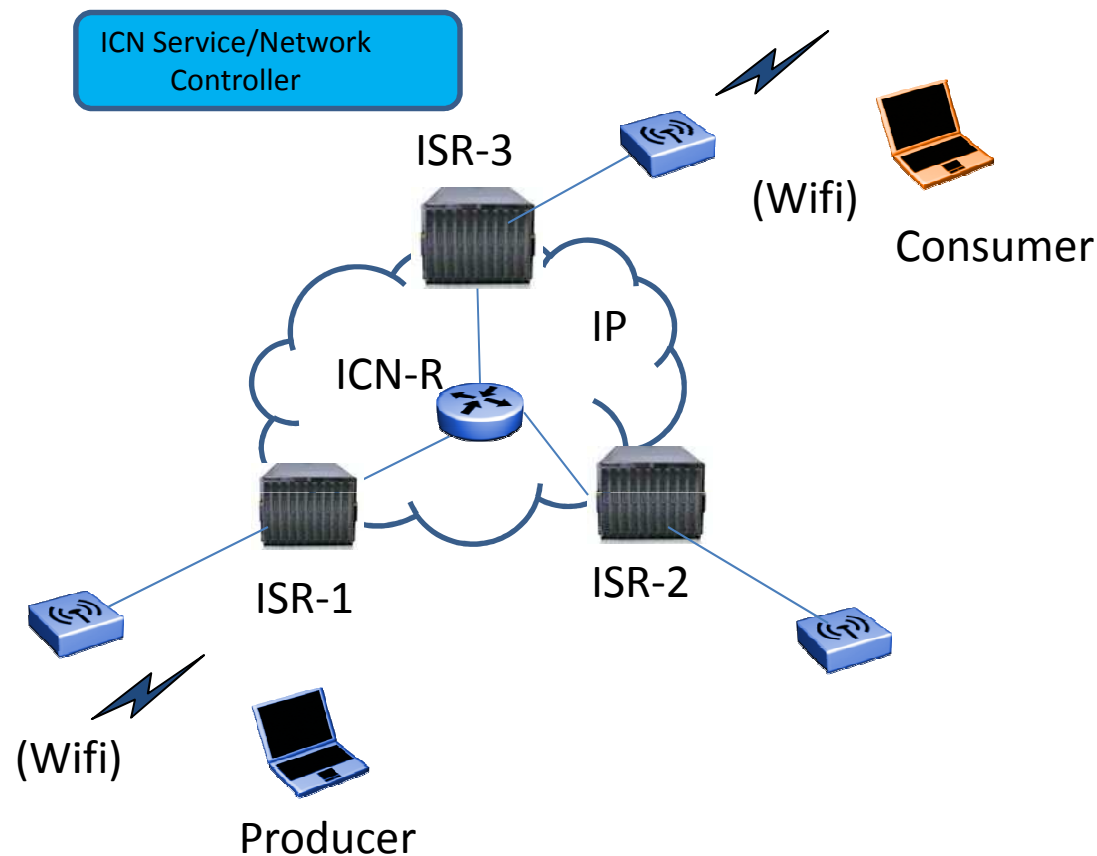
Producer Initiated **Versus** Network Initiated Mobility



- Network based mobility assumes, the previous MS Agent knows the set of candidate ISRs UE may handoff to.
- The previous ISR then pro-actively replicates Interest to the set of potential ISRs in the candidate list.
 - Accurate prediction can reduce the replicated Interest traffic.
- MS Agent sets the FLT cache table to multi-unicast the Interest to these candidate list of ISRs.



Test Setup and Evaluation

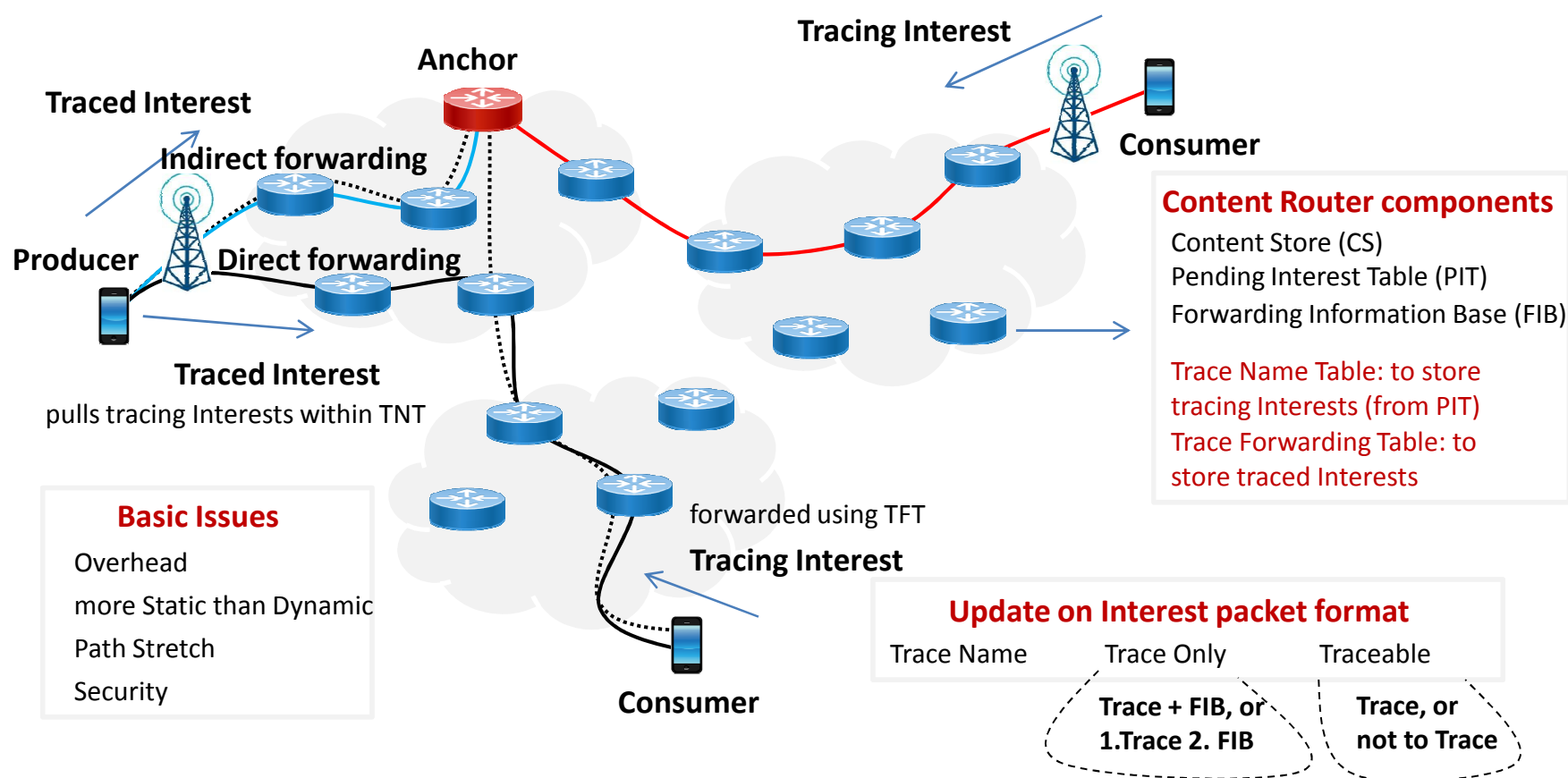


- 3 ISR and ICN-R
- Wifi Radio

Results



Anchor-based Approach to Mobility (Kite)

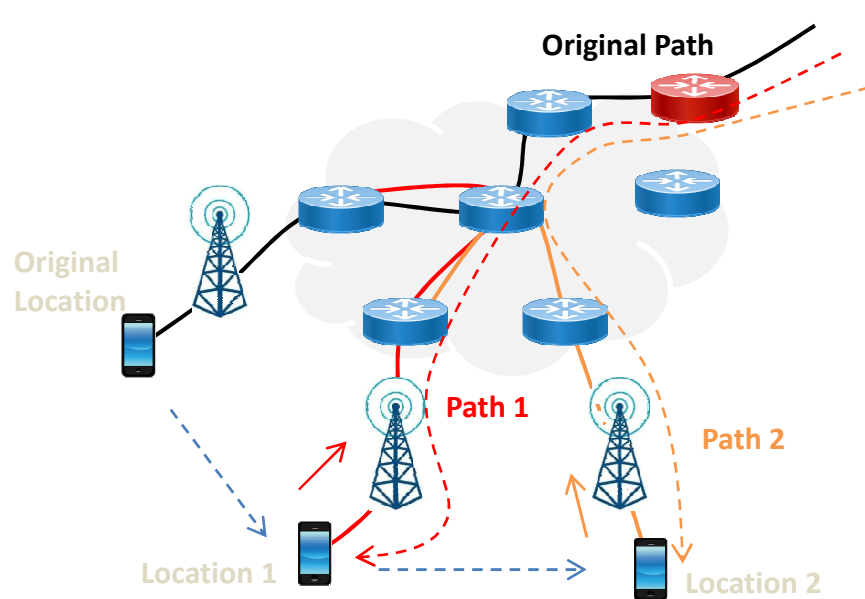


- Propose new components at the content router: **Trace Name Table** and **Trace Forwarding Table**
- Propose new Interest packet headers: **Trace Name**, **Trace Only** flag, and **Traceable** flag
- **Potential issues**: overhead of setting up and maintaining traces, **path stretch** due to use of **application-specific anchors**, concerns on security, etc.

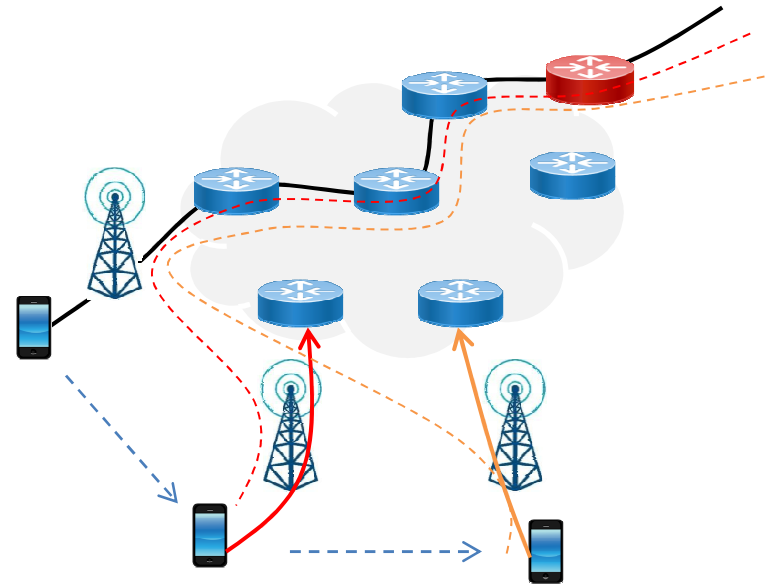
“Kite: A Mobility Support Scheme for NDN”, Y. Zhang, H. Zhang, L. Zhang, ACM ICN 2014.



Anchor-less Approach to Mobility



As Producer moves, **Interest Update** messages are sent to Producer's previous location (using FIB) to update Temporary-FIB entries



Interest Notification messages are sent to Point of Attachments to trigger local Temporary FIB update, with previous PoAs broadcasting received Interests to its neighbors

- Propose new component at the content router: **Temporary FIB**
- Propose new types of Interests: **Interest Update and Interest Notification**
- **Routing Churn issue due producer mobility**
- **Potential issues:** scalability (in number of mobile hosts and traffic rate), limitations due to PoA support requirements (if not supported at all points, seamless mobility cannot be guaranteed)

Current Proposals



Conclusions

