

Interframe Coding of Global Image Signatures for Mobile Augmented Reality

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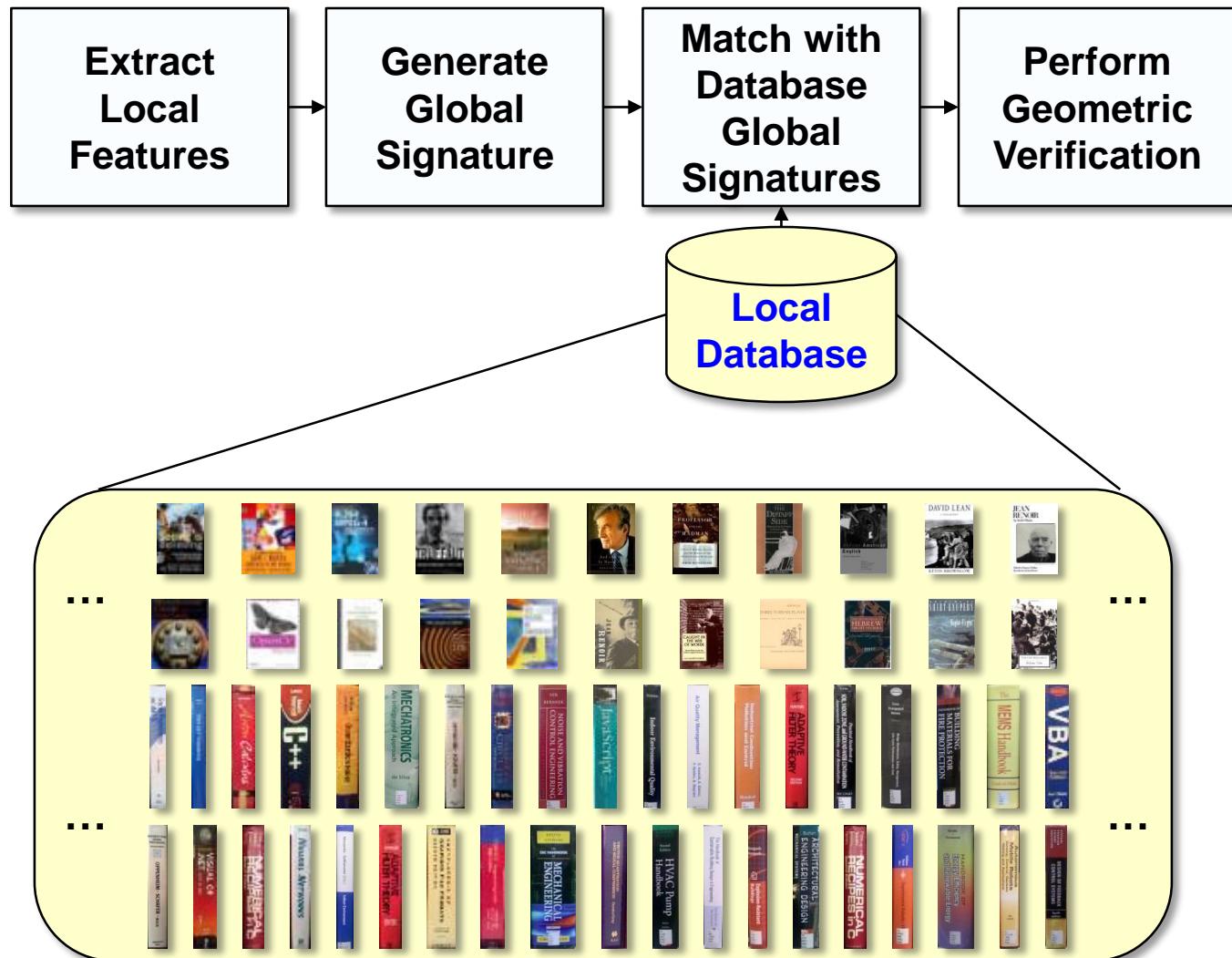
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²Qualcomm Inc.

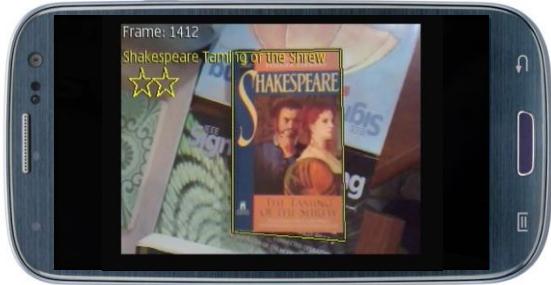


Samsung Galaxy S3 Smartphone

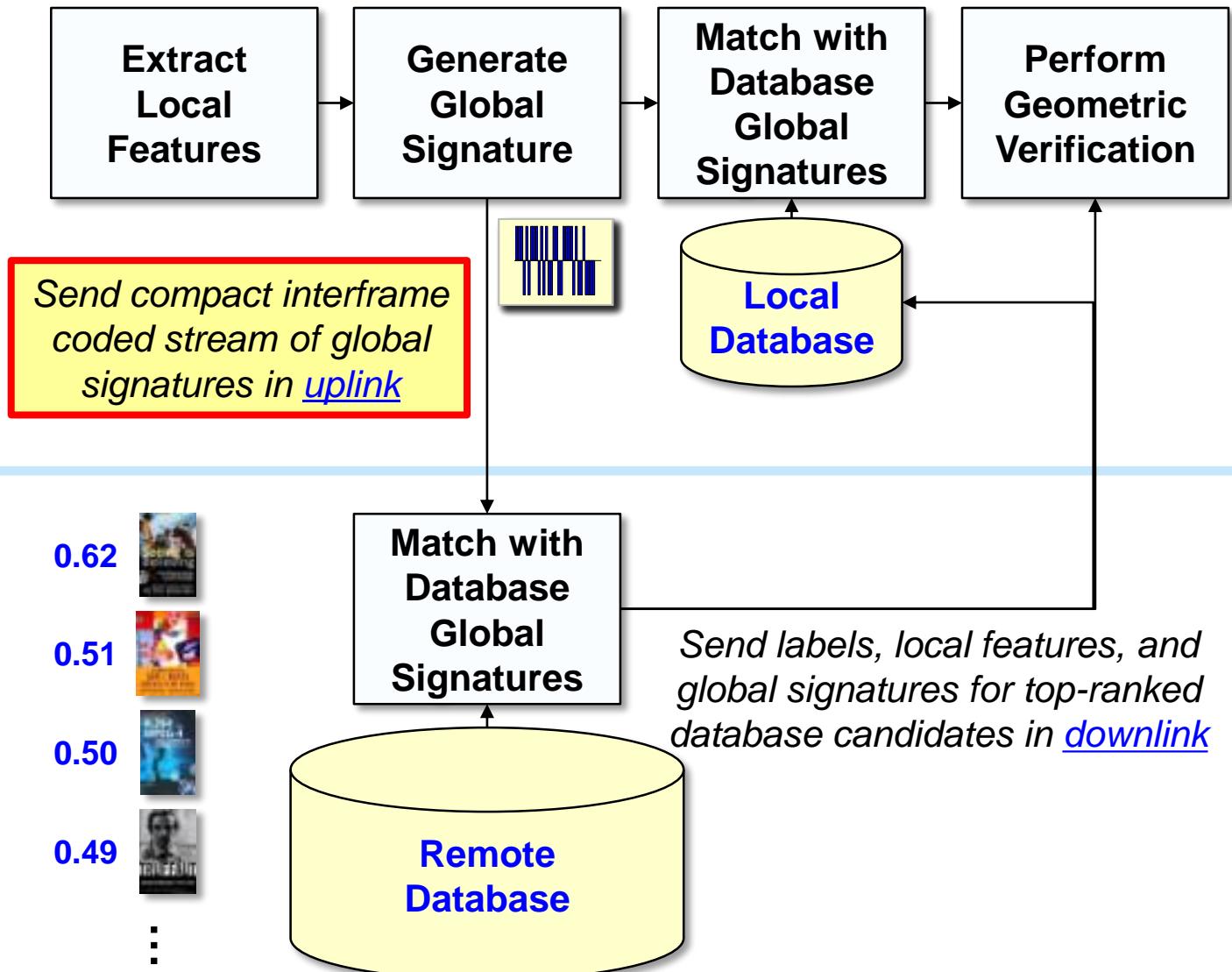
On-Device Image Matching System



Hybrid Image Matching System



Wireless Network



Outline

- Related work on feature compression
- Interframe coding of global signatures
 - Selective codeword propagation
 - Selective frame propagation
 - Selective frame propagation + local search
 - Global signature embedding
- Coding and retrieval results



Related Work on Feature Compression

Local
Image
Features

Random projections [Yeo, 2008]
Transform coding [Chandrasekhar, 2009]
Location histogram coding [Tsai, 2009]
CHoG [Chandrasekhar, 2009]
Bag of hash bits [He, 2011]

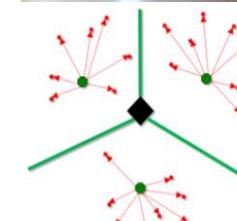
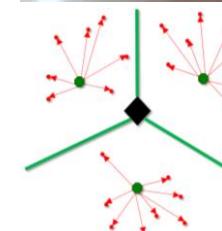
Temporally coherent keypoint detector
[Makar, 2012]

Descriptor and location predictive coding
[Makar, 2012] [Baroffio, 2014]

Global
Image
Signatures

Trace transform [Brasnett, 2007]
Tree histogram coding [Chen, 2009]
Residual vectors [Perronnin, 2010]
[Jegou, 2010] [Chen, 2011]

Our Current Work



Intraframe Coding

Interframe Coding



Temporally Coherent Keypoint Detection

Makar et al., 2012



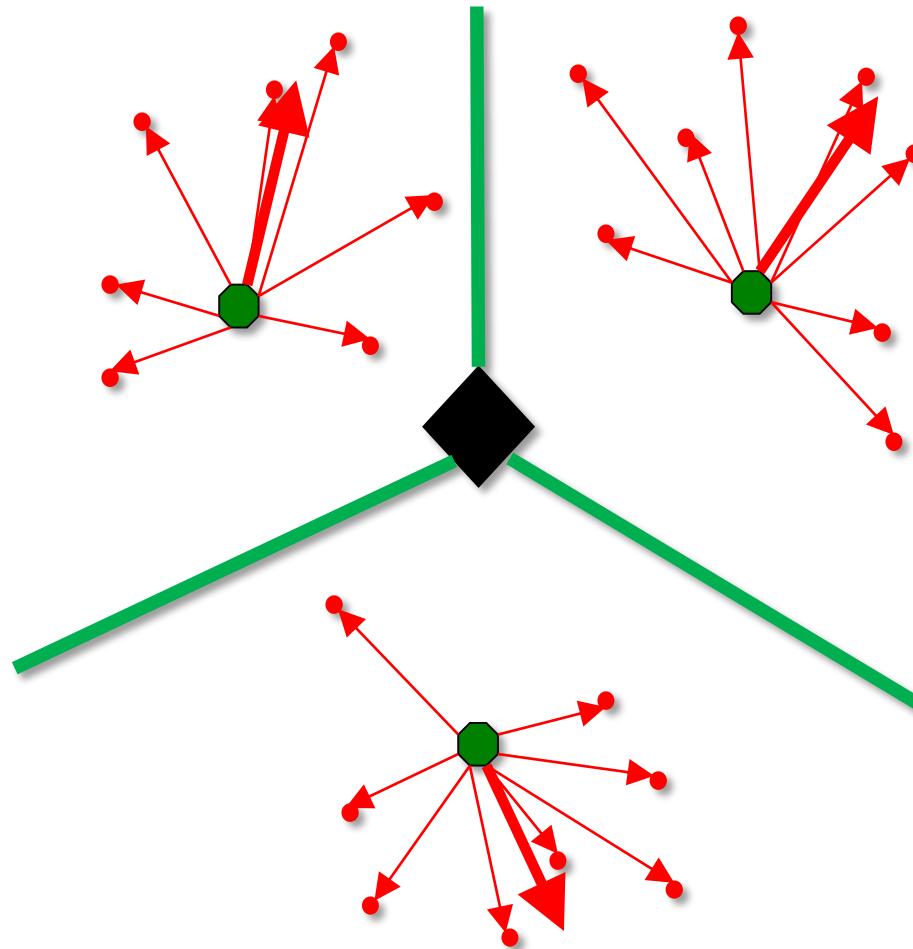
Detection (D) Frame



Forward Propagation (FP) Frame



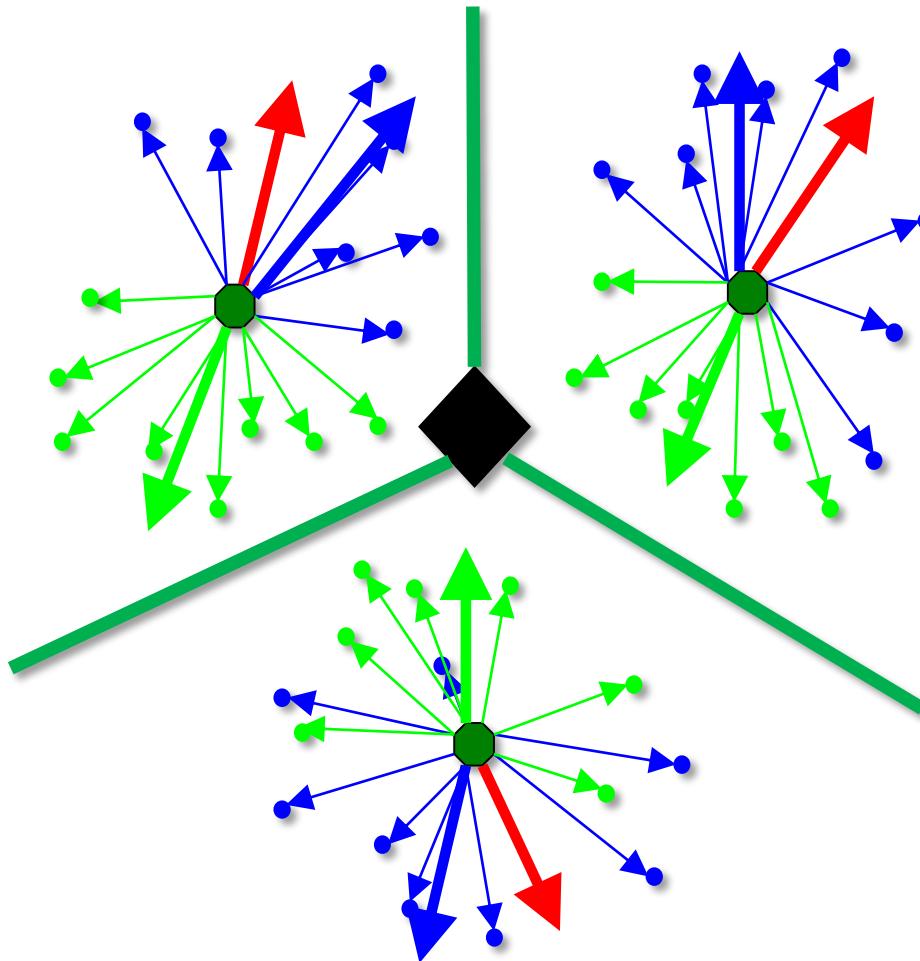
Generating Feature Residuals



$$k = 3$$



Generating Feature Residuals

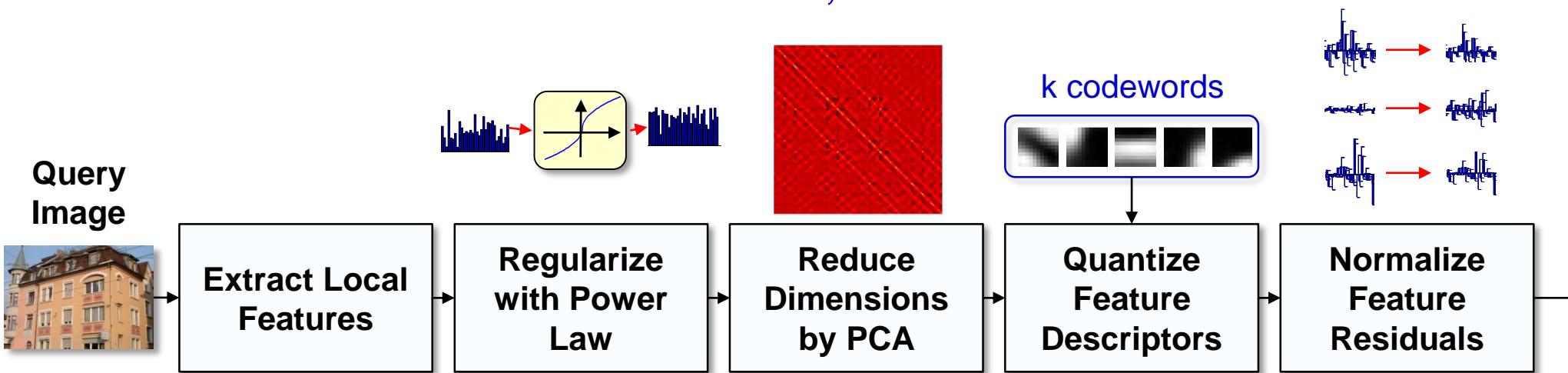


$$k = 3$$

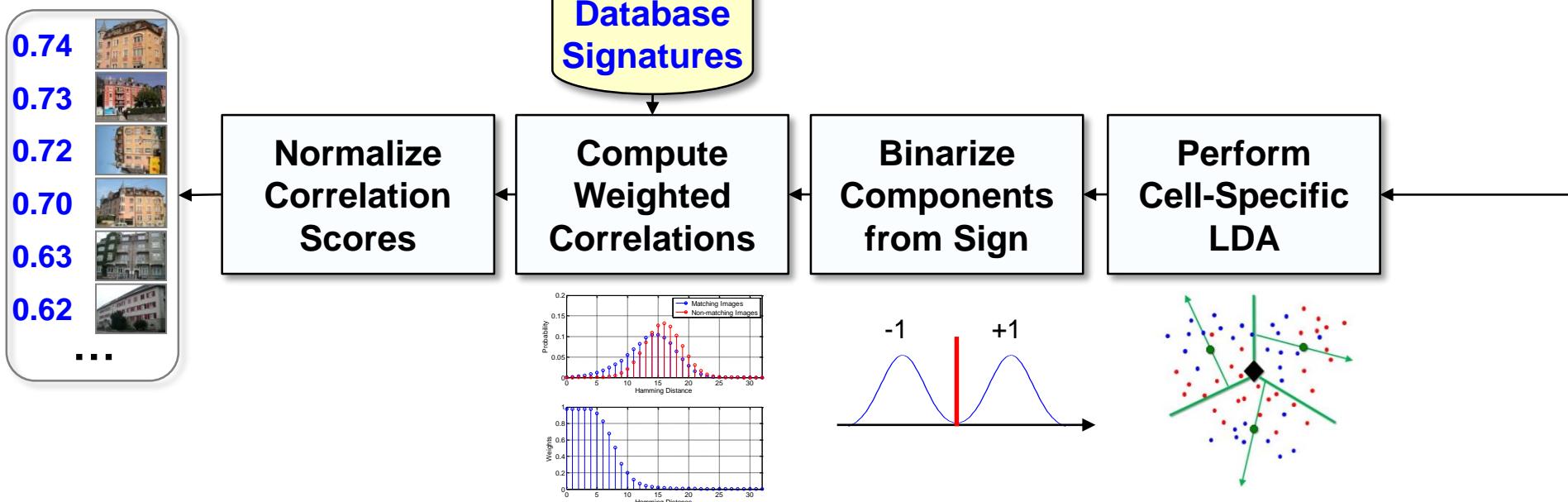


Residual Enhanced Visual Vector (REVV)

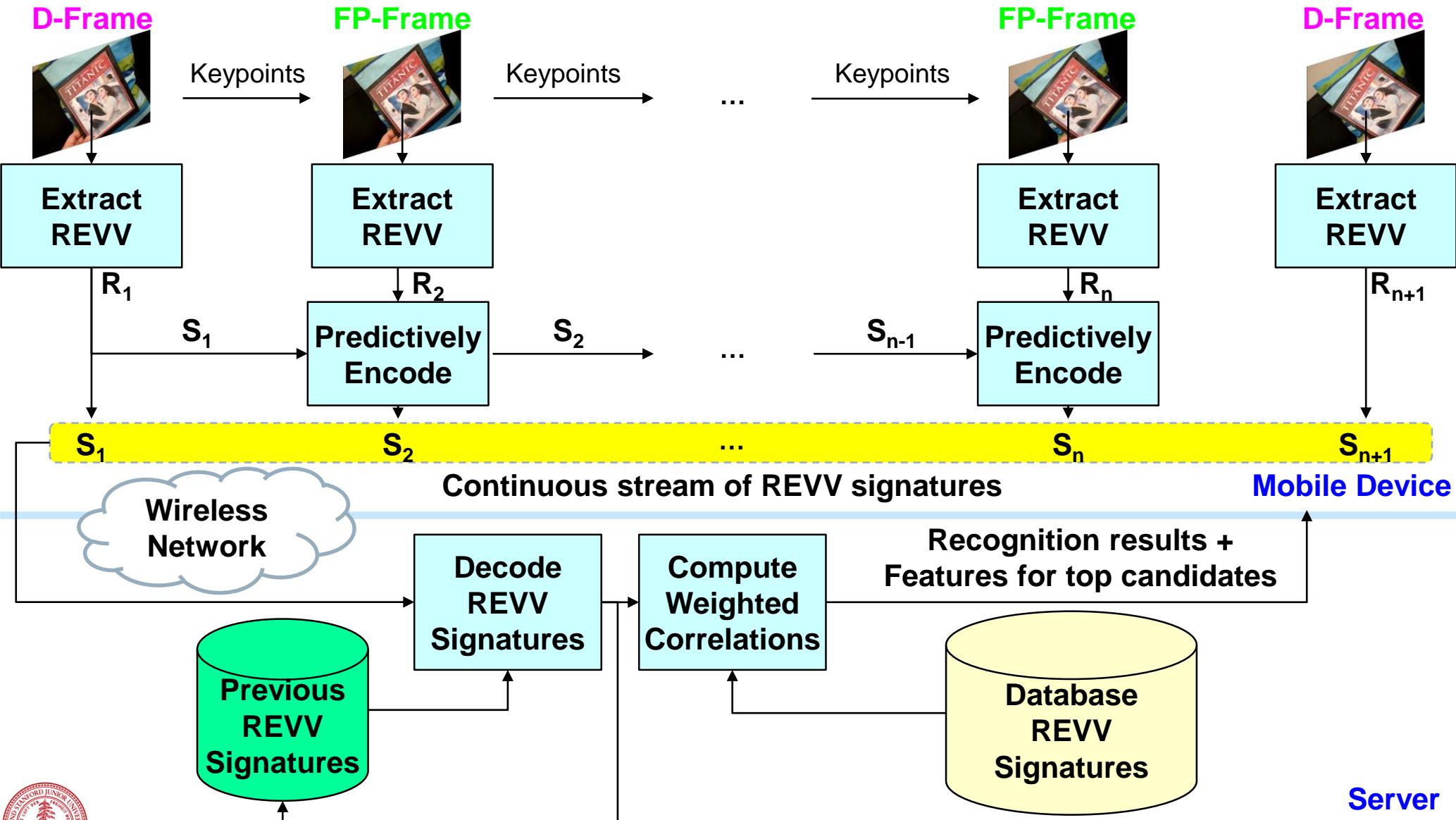
Chen et al., 2011



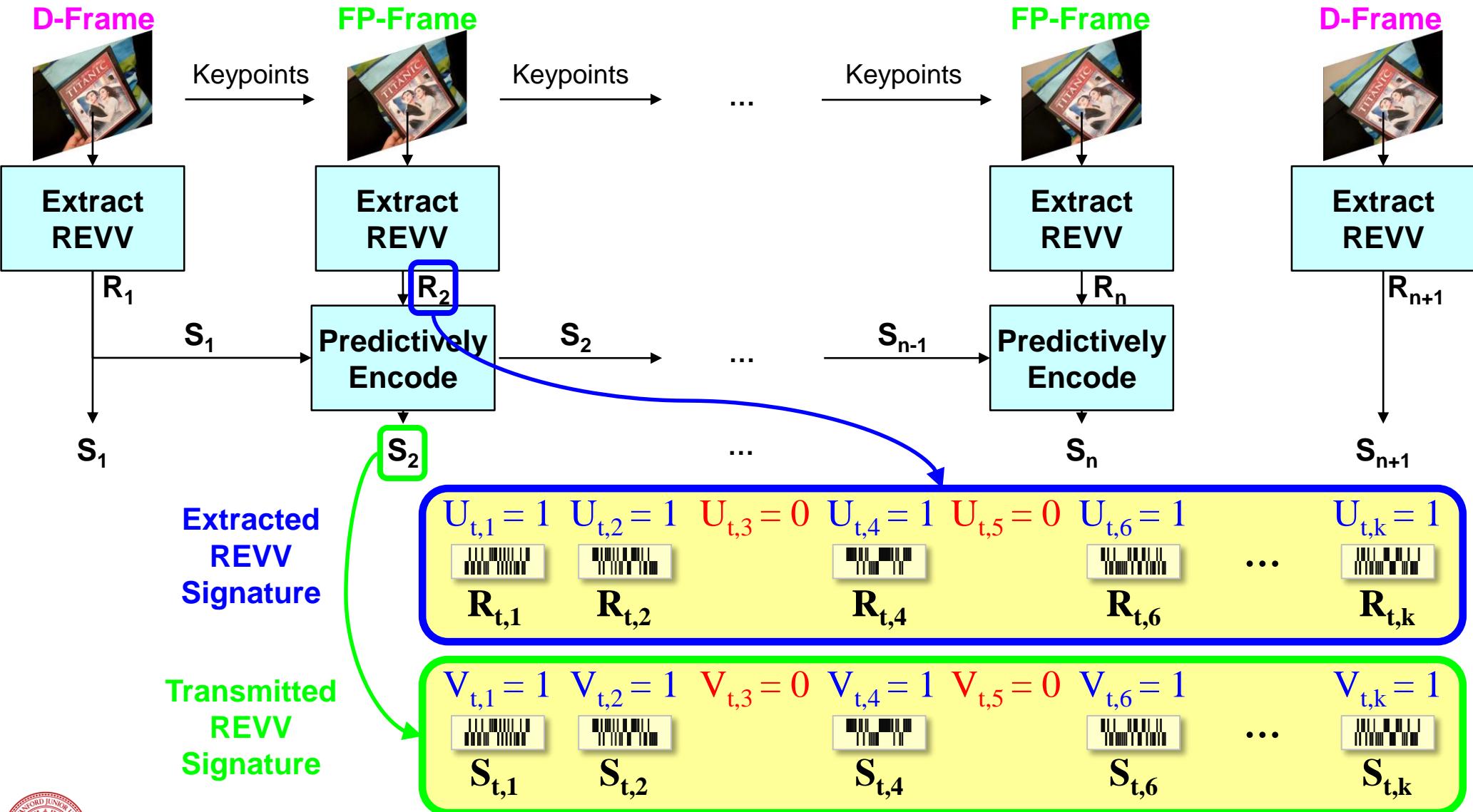
Ranked List



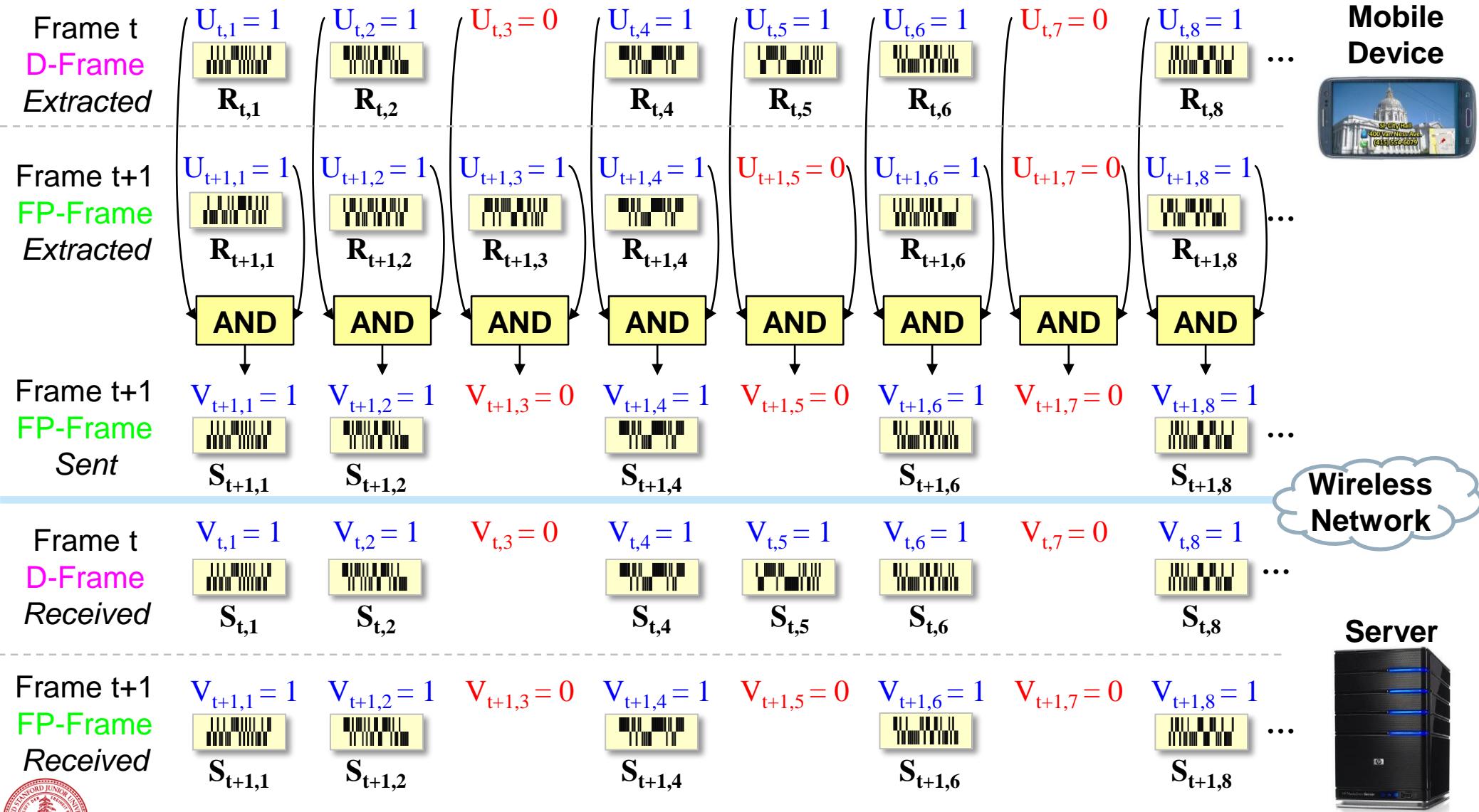
Interframe Coding of REVV



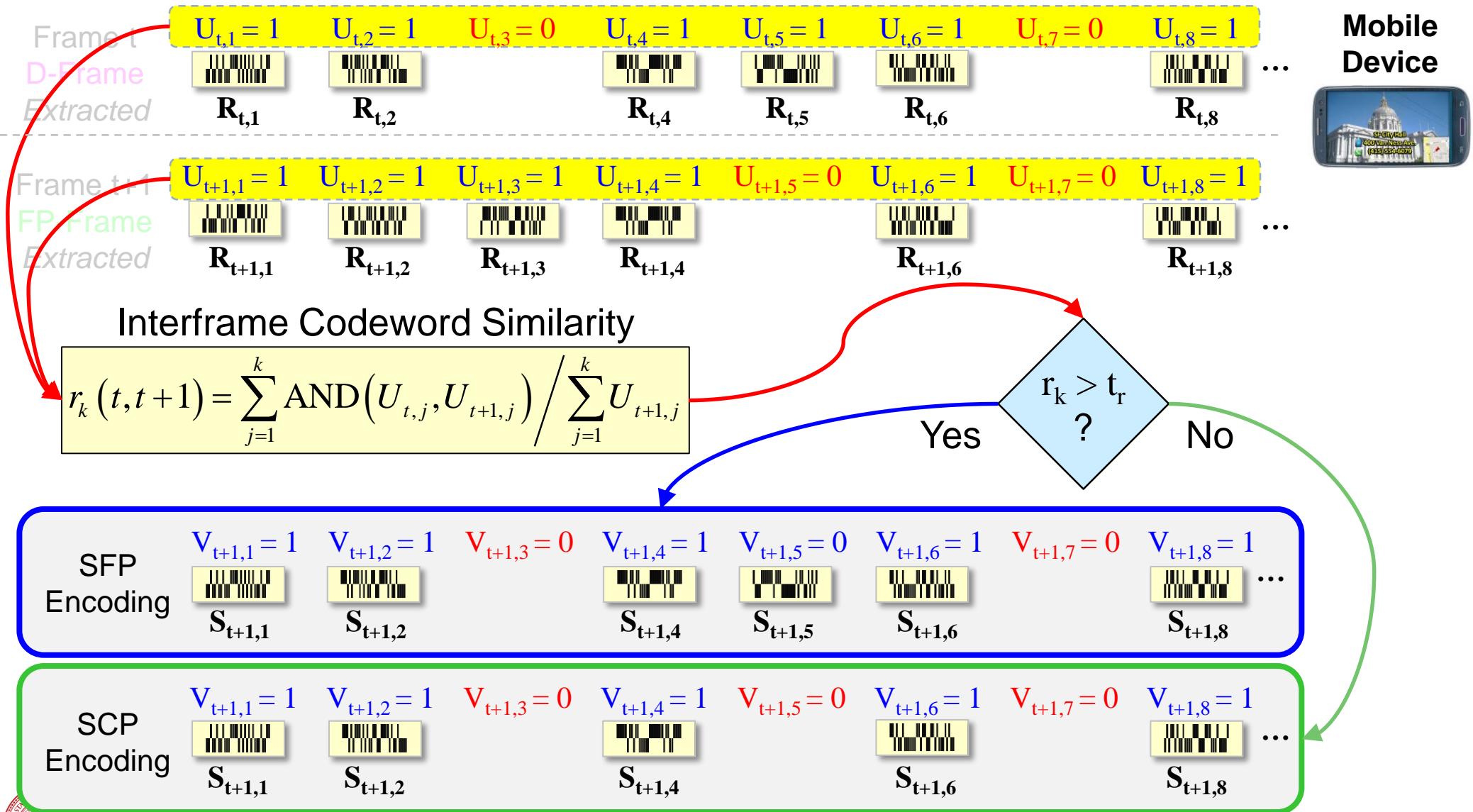
Interframe Coding of REVV



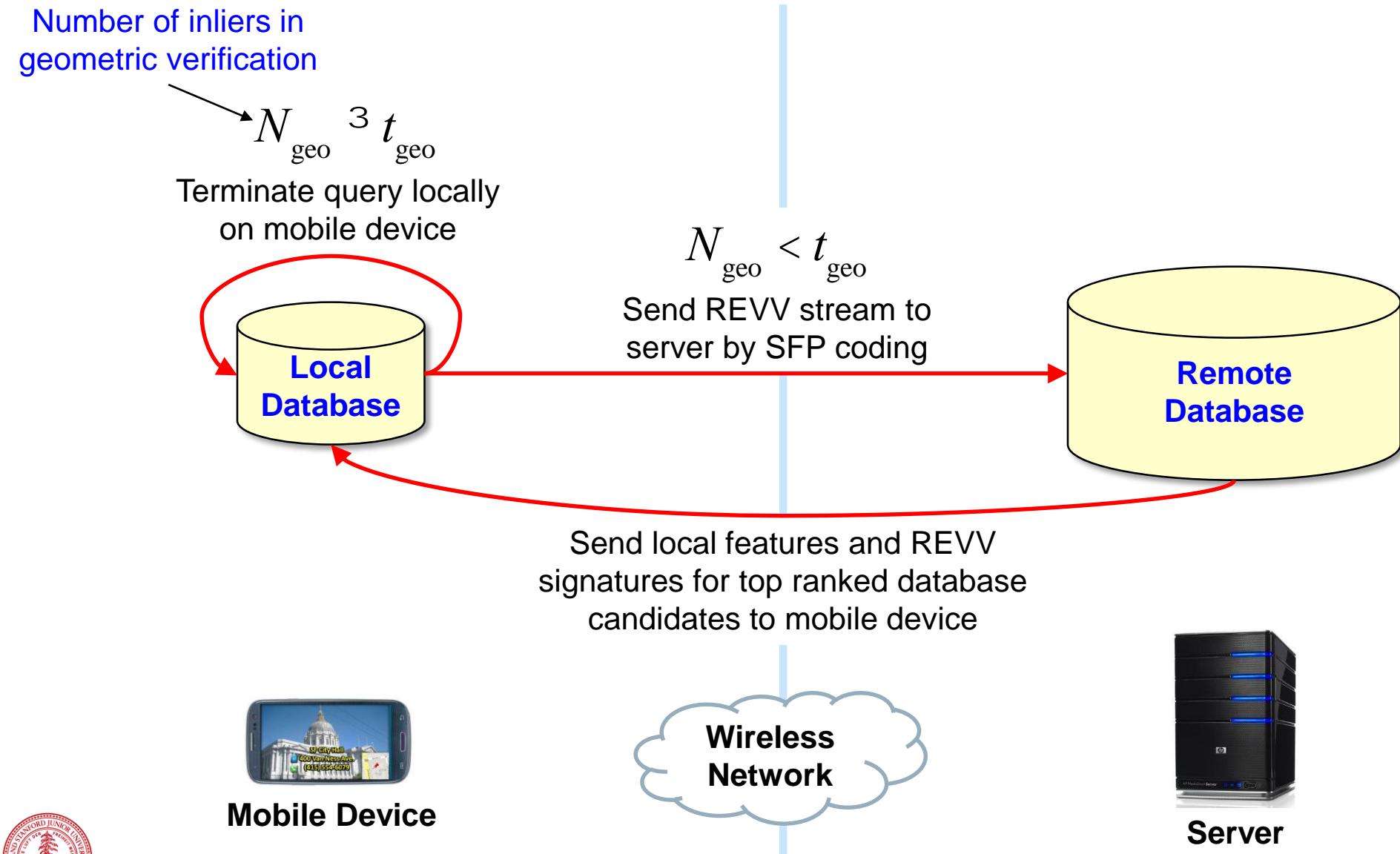
Selective Codeword Propagation (SCP)



Selective Frame Propagation (SFP)



SFP + Local Search (SFP + LS)



Embedded Global Signatures

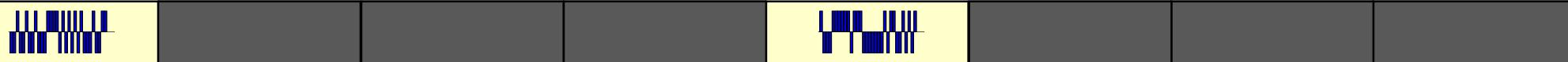
Codeword Codeword Codeword Codeword Codeword Codeword Codeword Codeword
1 2 3 4 5 6 7 8



Level 1 → Highest Bitrate



Level 2 → Medium Bitrate



Level 3 → Lowest Bitrate

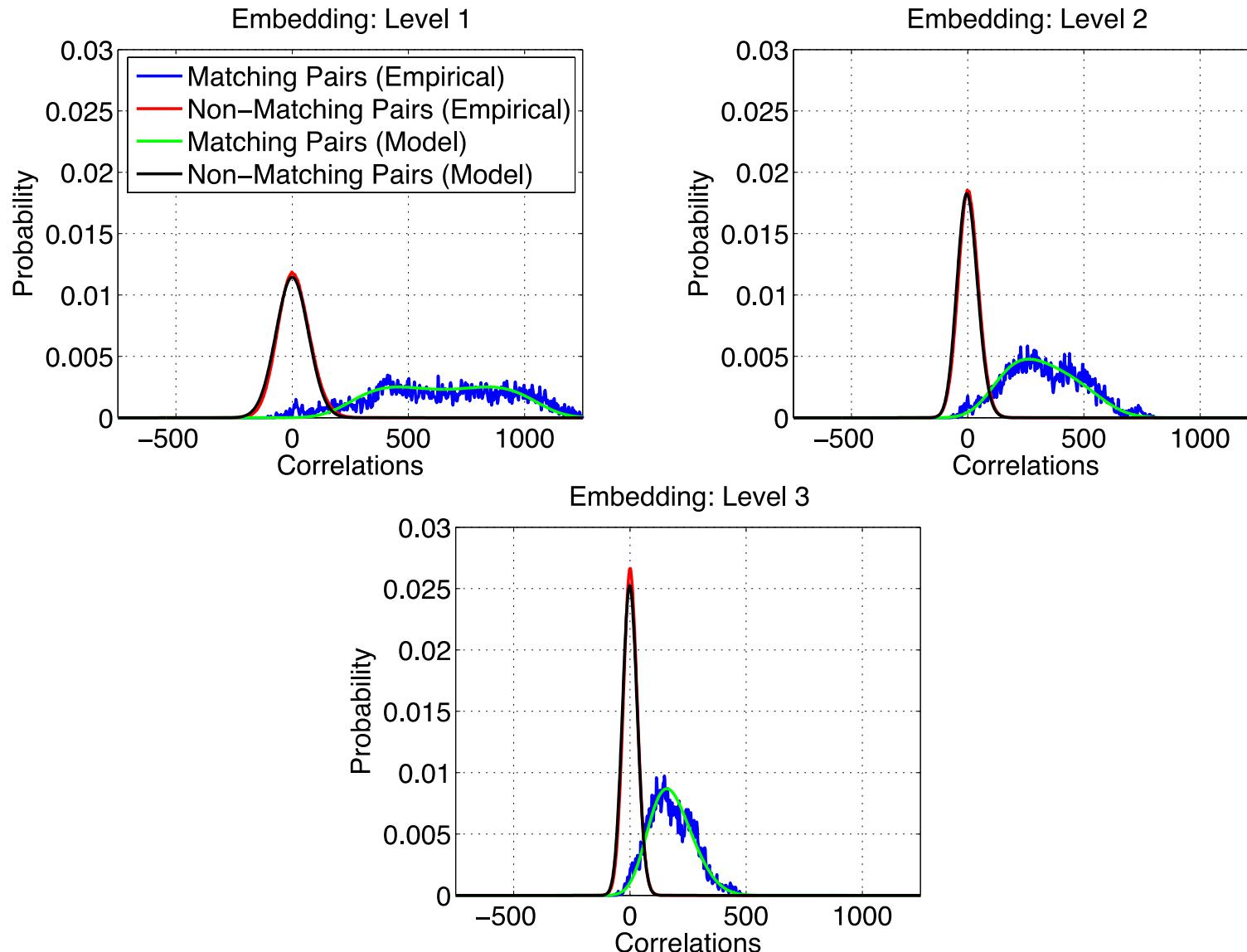


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Analysis of Retrieval Performance



Stanford Streaming MAR Dataset

Mobile Augmented Reality



32 VGA-resolution query videos recorded with a camera phone
Database of 23 labeled objects + 1M distractor images

[*Makar et al., 2013*]

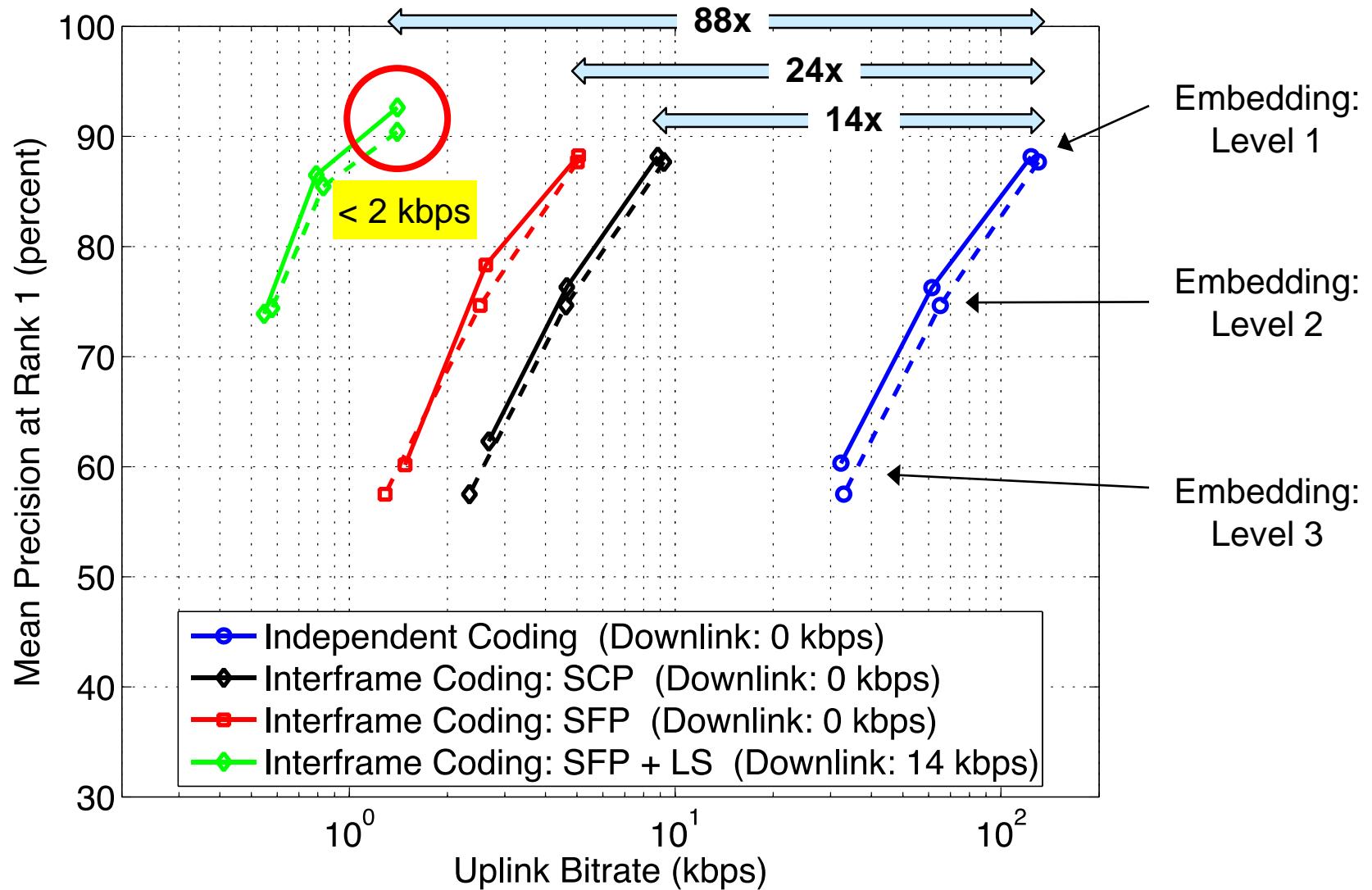


Experimental Setup

- Interframe coding parameters
 - $N_{D\text{-Frames}} = 1$ and $N_{FP\text{-Frames}} = 29$ for frame rate of 30 fps
 - Interframe codeword similarity threshold: $t_r = 0.9$
 - RANSAC threshold: $t_{\text{geo}} = 25$ feature matches
- REVV signature parameters
 - 250 SIFT features extracted for every D-Frame
 - Dimensionality reduction to $d_{LDA} = 32$
 - Codebook of $k = 190$ codewords
- Retrieval accuracy vs. uplink bitrate comparison



Retrieval Accuracy vs. Uplink Bitrate



Conclusions

- Developed efficient methods for interframe coding of a continuous stream of global REVV signatures
 - Adapts bitrate in response to current viewfinder contents
 - Combines advantages of local and remote database search
 - Performs local database update at same time as query expansion
- Analyzed how retrieval accuracy varies with bitrate
 - Models distributions of REVV correlation scores
 - Quantifies bitrate savings for all coding methods
- Achieved substantial bitrate savings
 - Reduces uplink bitrate by almost 2 orders of magnitude
 - Requires only a small downlink bitrate



A photograph of the Stanford Memorial Church in Stanford, California. The church features a large, ornate facade with a central arched entrance. Above the entrance is a large, colorful mosaic depicting a scene from the Bible. A golden cross sits atop the gabled roof. In the foreground, a large, semi-transparent red rectangular box contains the text "Thank You".

Thank You

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