MODULARITY IN

DISTRIBUTED FEATURE COMPOSITION

and

THIRTEEN YEARS OF LEARNING FROM MICHAEL JACKSON

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SOME THINGS I LEARNED FROM MICHAEL

WHAT TO SAY . . .

. . . after asking the staff of a restaurant to turn the music down, and being told, "We can't, the customers like it."

(possibilities too numerous to list)

WHY THE WORD "MULTIPARADIGM" IS BAD

"Multi paradigm" is a chimera.

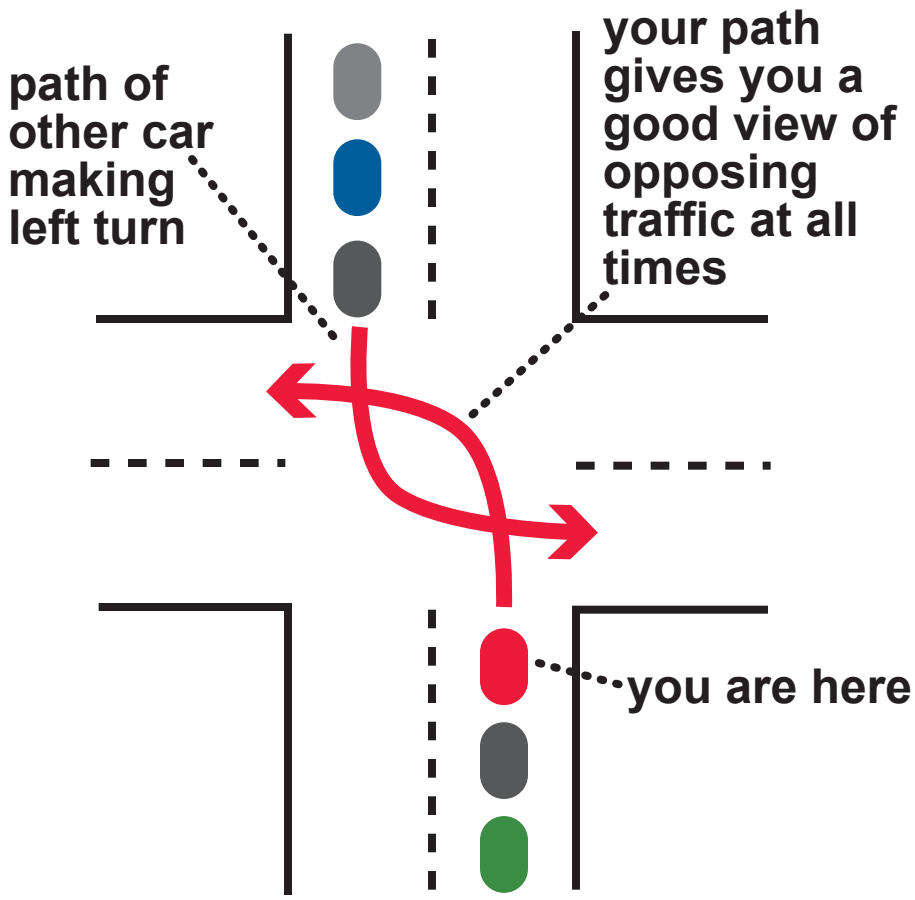
Latin origin

Greek origin

an imaginary monster compounded of incongruous parts

Start using "polyparadigm".

HOW TO MAKE A LEFT TURN, WHILE DRIVING IN NORTH AMERICA



(despite his many efforts to persuade us, no one at AT&T Research has ever had the courage to attempt this)

TELECOMMUNICATION SERVICES . . .

. . . ARE CONCEIVED AND BUILT IN TERMS OF FEATURES SUCH AS:

Parallel Ringing
Quiet Time
Voice Mail

Speed Dialing
Outgoing Call Blocking
Voice Dialing

Call Waiting
Transfer
Conference

FEATURE CHURN

- features are being added and changed continually
- are optional for each subscriber
- can often be enabled/disabled dynamically by their subscribers

FEATURES INTERACT WHEN ONE FEATURE MODIFIES OR INFLUENCES ANOTHER

FEATURE INTERACTIONS ARE VERY COMMON

- all features are modifying or enhancing the same basic service, which is real-time communication among people
- the number of interactions is combinatorial in the number of features

FEATURE CHURN AND FEATURE INTERACTIONS HAVE CAUSED SEVERE SOFTWARE PROBLEMS IN THE CIRCUIT-SWITCHED TELEPHONE NETWORK

(ever since it became software-controlled in the 1960s)

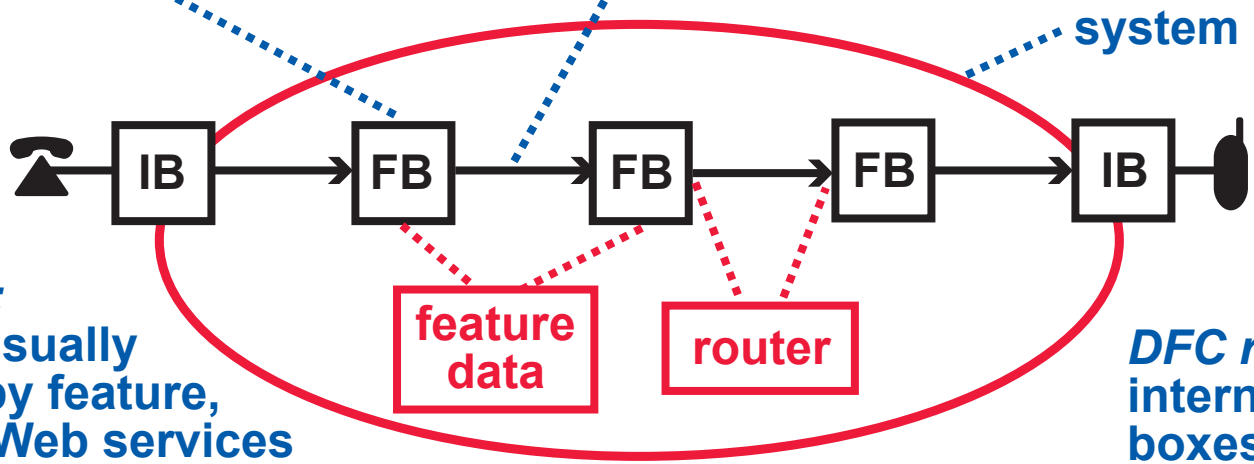
DISTRIBUTED FEATURE COMPOSITION (DFC) . . .

. . . IS AN ADAPTATION OF THE PIPES-AND-FILTERS ARCHITECTURE TO TELECOMMUNICATION SERVICES

usage: a dynamically assembled graph of boxes and internal calls

box: a concurrent process, providing either interface or feature functions

internal call: a featureless, point-to-point connection with a two-way signaling channel and any number of media channels



feature data: persistent, usually partitioned by feature, interface to Web services

DFC router: routes internal calls to boxes

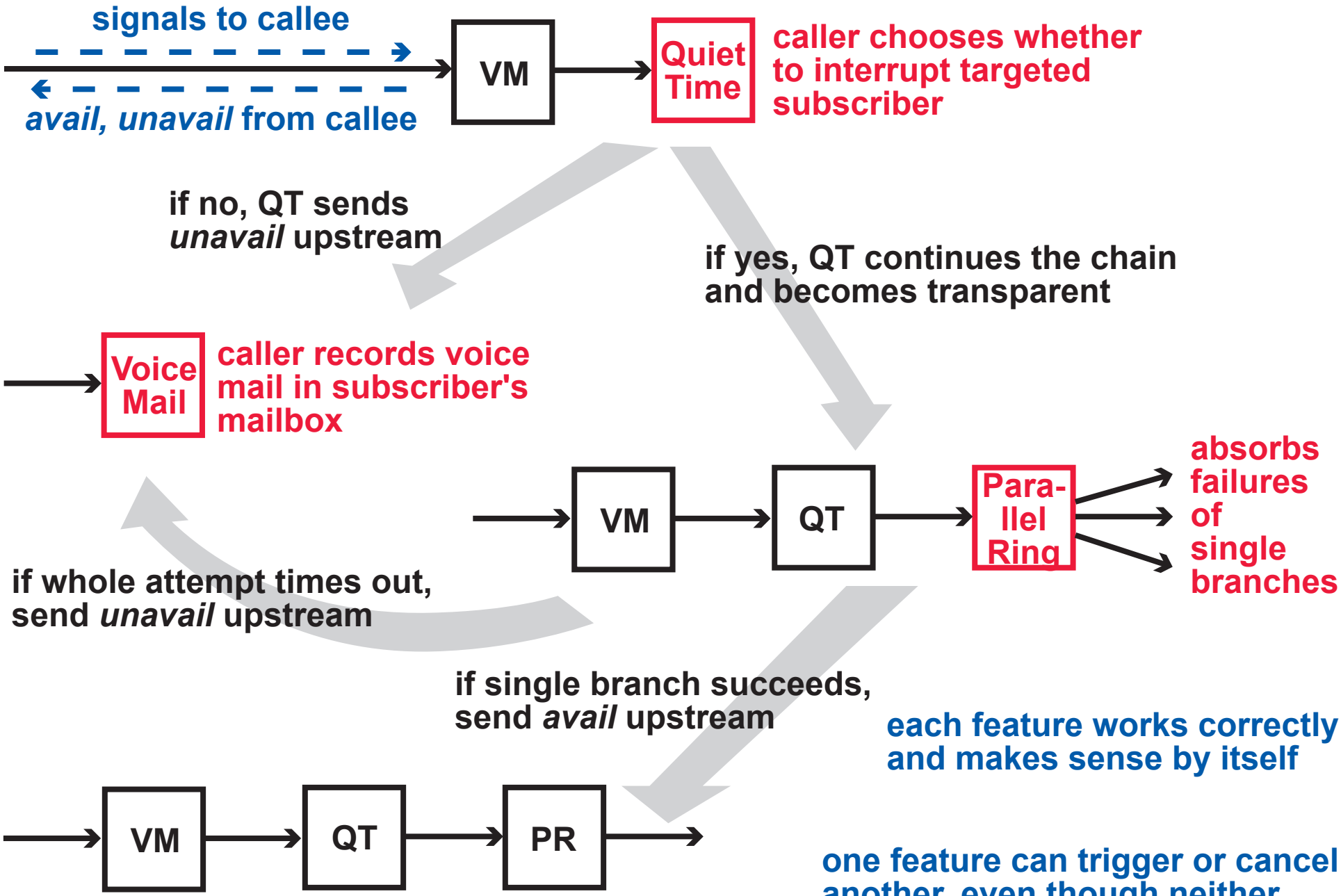
BECAUSE A FEATURE BOX HAS . . .

- transparency
- autonomy
- context independence

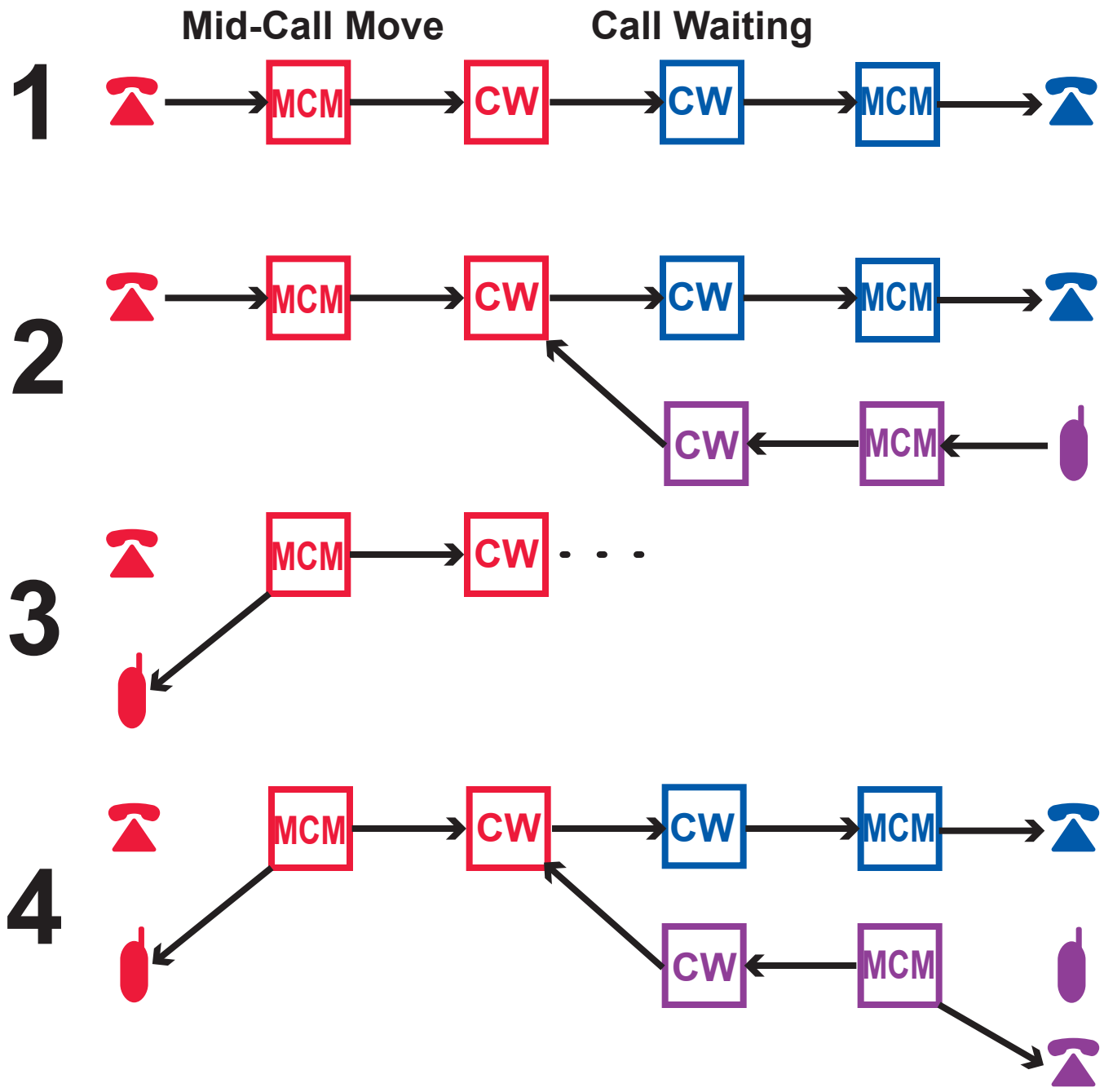
. . . THE ARCHITECTURE SUPPORTS

- feature modularity
- structured feature composition
- management of feature interactions

SIGNALING INTERACTIONS



ROUTING INTERACTIONS



no feature box ever manages more than three internal calls

dynamic reconfiguration is performed automatically by the DFC routing algorithm

preserves the invariant that every person has his features in every relevant path, in the correct order

in general, a signaling path consists of segments set up in alternating directions

AT&T CALLVANTAGE[SM] SERVICE 2003-2004

. . . is a consumer, broadband, voice-over-IP service.
Its advanced features were built with DFC.

FEATURE DEVELOPMENT

- a group of researchers delivered eleven complex features . . .

  e.g., Mid-Call Move
  Ten-Way Calling
  Parallel Find Me

  . . . two months from the inception of the project

  this is unprecedented speed

- all the feature interactions were successfully analyzed and managed during the same two months

SYSTEM INTEGRATION

- many integration problems with vendor-supplied components (IP routers, gateways, phone adaptors, media servers)
- DFC modularity was extremely useful for adding adaptors to patch over integration problems

  don't want to embed these in the service

DEPLOYMENT AND EVOLUTION

- supported many thousands of customers world-wide (without two media-intensive features)
- easy feature evolution
- the service won two industry awards, citing voice quality and advanced features

T-MEETING

. . . is a teleconferencing system for internal use at AT&T.
It was built entirely with DFC.

PHASE ONE (2006)

- has mid-conference control from both phone and Web, recording, active speaker identification, user switching between multiple conferences
- during development, modularity supported functional prototyping, code reuse, deferred design decisions
- as with CallVantage, there were very few bugs in the application code
- supports millions of user minutes on a typical workday

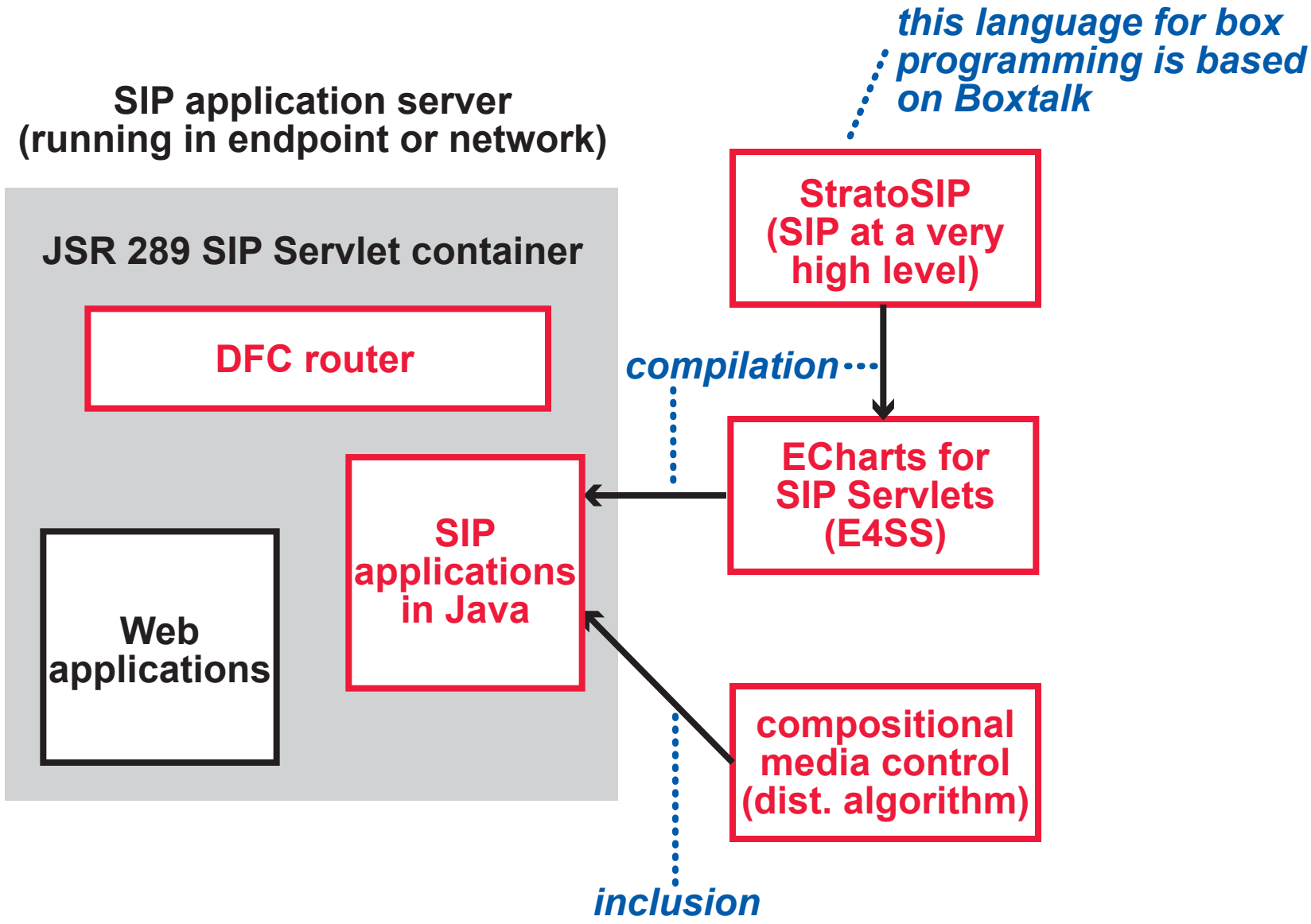
PHASE TWO (ongoing)

- a re-implementation with our new standards-based software tools

SOME OF OUR NEW STANDARDS-BASED TOOLS

SIP IS THE DOMINANT SIGNALING PROTOCOL FOR IP-BASED MULTIMEDIA APPLICATIONS

THESE TOOLS IMPLEMENT DFC ON TOP OF SIP



DISTRIBUTED FEATURE COMPOSITION REALLY WORKS

WITHIN THE DOMAIN OF TELECOMMUNICATION SERVICES, MODULARITY IS GENERAL-PURPOSE

- feature modularity: a feature is an addition or exception to the basic service
  the original purpose
- module is an addition or exception to another feature
- modularity isolates probable change
- module is a unit of re-usable code
- module is an adaptor
- an off-the-shelf component is packaged as a module for better integration
- modularity opens services to applications from the public
  now 25,000 iPhone apps in the store

MANAGEMENT OF FEATURE INTERACTIONS IS MORE THAN ANALYSIS

studying each class of interaction tends to yield deep domain knowledge . . .

. . . of how and why features interact in that way

. . . of which interactions are desirable and which are undesirable

. . . of how features should be managed to prevent the bad interactions and enable the good ones

without the architecture, there would be no limits on how features could interact

AFTER TWELVE YEARS, DISTRIBUTED FEATURE COMPOSITION IS STILL AHEAD OF ITS TIME

It is a challenge to explain DFC modularity, composition, and abstractions to the SIP community, . . .

. . . although the need for them is urgent.

The DFC routing algorithm fills an unmet need in the Internet architecture.

Being rich in functions, it may be as general as will ever be needed.

Being expensive to implement in some contexts, there are niches for other versions with fewer functions.

HOW TO THINK LIKE MICHAEL JACKSON

?