CALM INTERFACES FOR INTEGRATED C2 SYSTEMS

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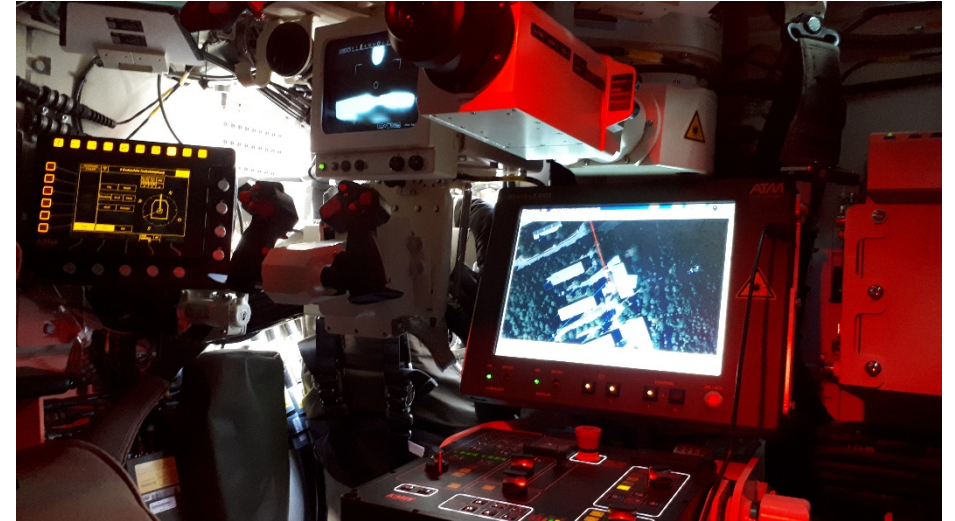
Aim

- Develop a multimodal, distributed Voice User Interface for C2 Information Systems in tanks.

- Follow the maxims of calm technology to assure that system interaction does not consume the operator.

Motivating scenario

- Let us assume that a tank is equipped with an integrated C2 Information System (C2IS).

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- The tank crew consists of a commander, a gunner, a loader and a driver. Both the commander and the gunner can operate the C2IS. However, for the sake of simplicity, we assume that only the commander operates the system.

- The tank is equipped with an intercom system via which the crew communicates and which, in principle, can be connected to the C2IS.

- The commander observes the surroundings through a periscope. He can determine the position of recognized objects with a laser.

- The commander creates structured representations of recognized objects, i.e., Battle Space Objects (BSOs). BSOs are the basis for depicting objects by symbols on the map.

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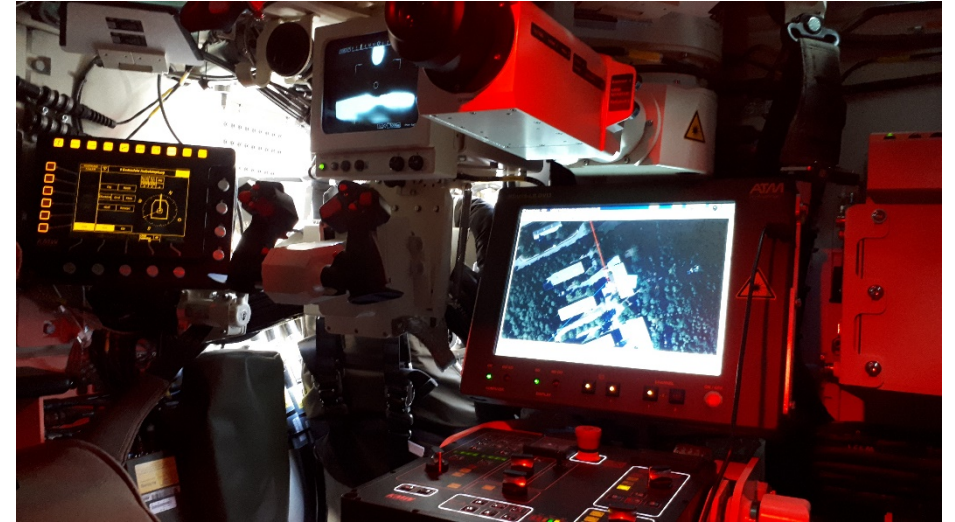
Perceived usefulness of an integrated C2IS

- The essential value of an integrated C2IS is beyond doubt: the operational picture is of great value, in particular in situations with reduced visibility.

- However, operators experience the *actual* value of an integrated C2IS lower, since update rates of information are considered too low and, in consequence, the operational picture is not always complete and up-to-date.

- Why is that?

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Use Case 1: Creation of a new Battle Space Object
Battle tank, hostile, West direction (Kampfpanzer, feindlich, in Ausrichtung West)

Interaction via GUI:

- View through periscope, determine position by laser, dummy symbol appears on map

- View on map, select dummy symbol (touchscreen)

- Determine object type by selecting a respective symbol from a pre-defined table (touchscreen)

- Take keyboard, enter further information

- Send BSO report and close interaction (touchscreen)

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Interaction via VUI:

- View through periscope, determine position by laser, a respective mark appears in periscope

- Start speech recognition, give speech input

- Automatic Speech Recognition, symbol of recognized object appears both in periscope and on map

- Further voice commands for sending BSO report and closing interaction

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Referring to the same object again

- Battle tank, hostile, in position, West direction.

- Battle tank, destroyed.

- Battle tank, hostile, in position, West direction, Name Brady One.

- Brady One. Destroyed.

Use Case 2: Information Update on a Battle Space Object
Battle tank, destroyed (Kampfpanzer, zerstört)

Interaction via GUI:

- View on map, select object (touchscreen)

- Update attributes (touchscreen and/or keyboard)

- Send update and close interaction (touchscreen)

Use Case 2: Information Update on a Battle Space Object
Battle tank, destroyed (Kampfpanzer, zerstört)

Interaction via GUI:

- View on map, select object (touchscreen)

- Update attributes (touchscreen and/or keyboard)

- Send update and close interaction (touchscreen)

Interaction via VUI:

- Name object (speech input)

- Update attributes (speech input)

- Send update and close interaction (speech input)

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Use Case 2: Information Update on a Battle Space Object
Battle tank, destroyed (Kampfpanzer, zerstört)

Interaction via GUI:

- View on map, select object (touchscreen)

- Update attributes (touchscreen and/or keyboard)

- Send update and close interaction (touchscreen)

Interaction via VUI:

- Name object (speech input)

- Update attributes (speech input)

- Send update and close interaction (speech input)

or

- View through periscope, determine position by laser, name object (speech input), thereby update position, send and close interaction (speech input)

Interim Stock-taking

- Usefulness and usability of a C2IS are interconnected: C2IS must be easily usable to assure a sufficiently high update rate and, thus, usefulness.

- Usability can be enhanced by applying Automatic Speech Recognition (ASR). However, the tank environment provides challenging conditions for ASR.

Adverse conditions for Automatic Speech Recognition (ASR)

- Noise pollution

- Constant movement and shaking

- Crew under considerable pressure

  - affects voice and language (pitch, intensity, speech rate, articulatory precision)

  - reduces ability and readiness to correct mistakes

  - reduces patience in handling a complex system

- A speech interface must be easy to operate and work robustly even under adverse condition.

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- Interaction with a C2IS must not absorb the operator. Systems must be *calm*.

Calm Technology

1. Technology should require the smallest possible amount of attention.
2. Technology should inform and create calm.
3. Technology should make use of the periphery.
4. Technology should amplify the best of technology and the best of humanity.
5. Technology can communicate but doesn't need to speak.
6. Technology should work even when it fails.
7. The right amount of technology is the minimum needed to solve the problem.
8. Technology should respect social norms.

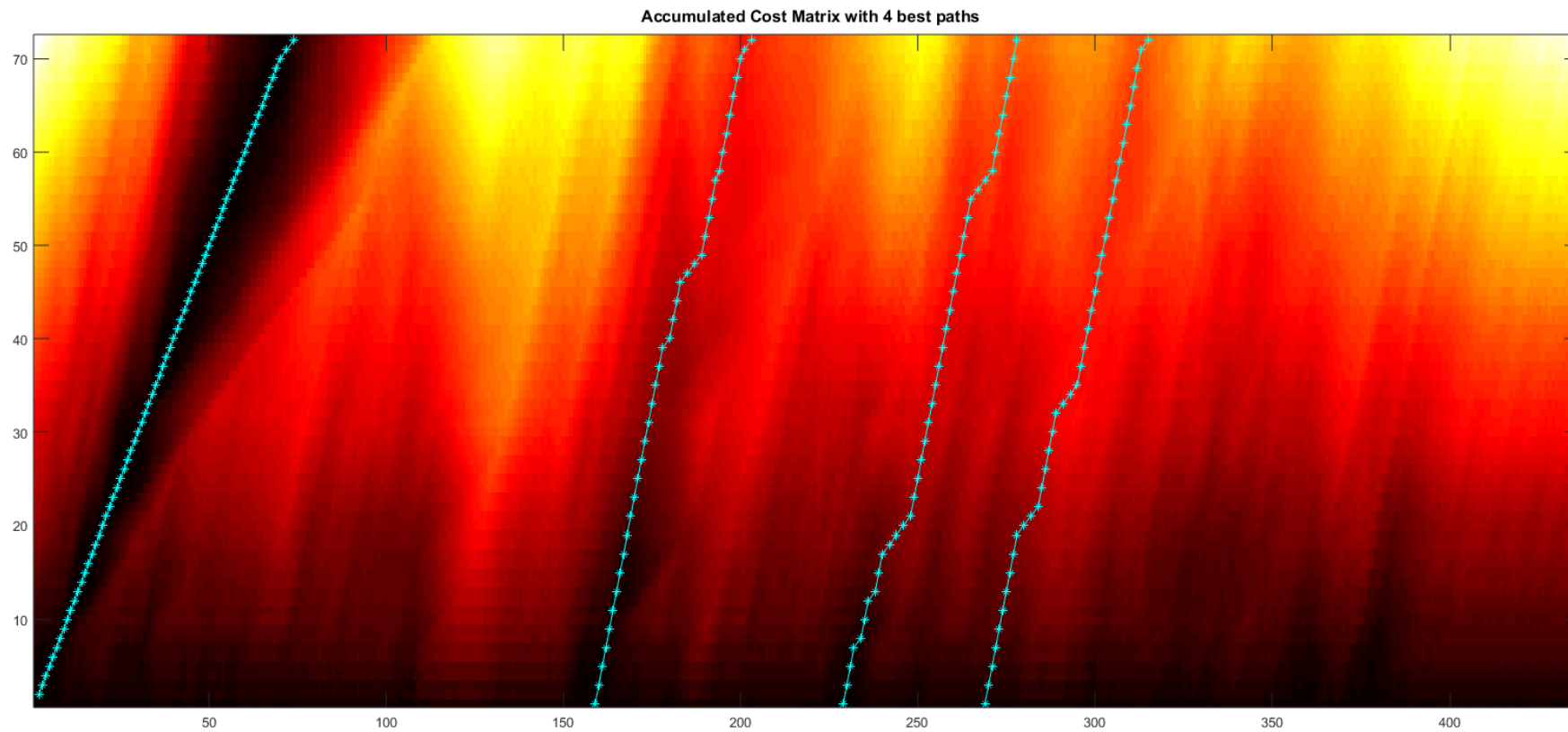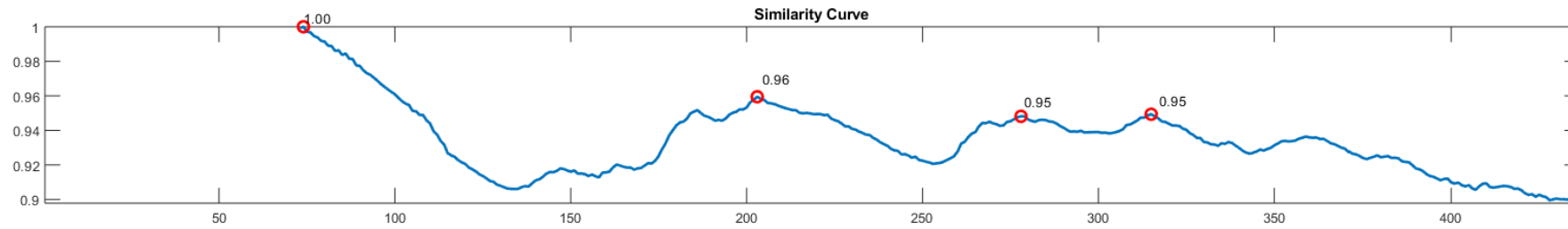[Case 2016] [Marc Weiser, John Seely Brown 1995]
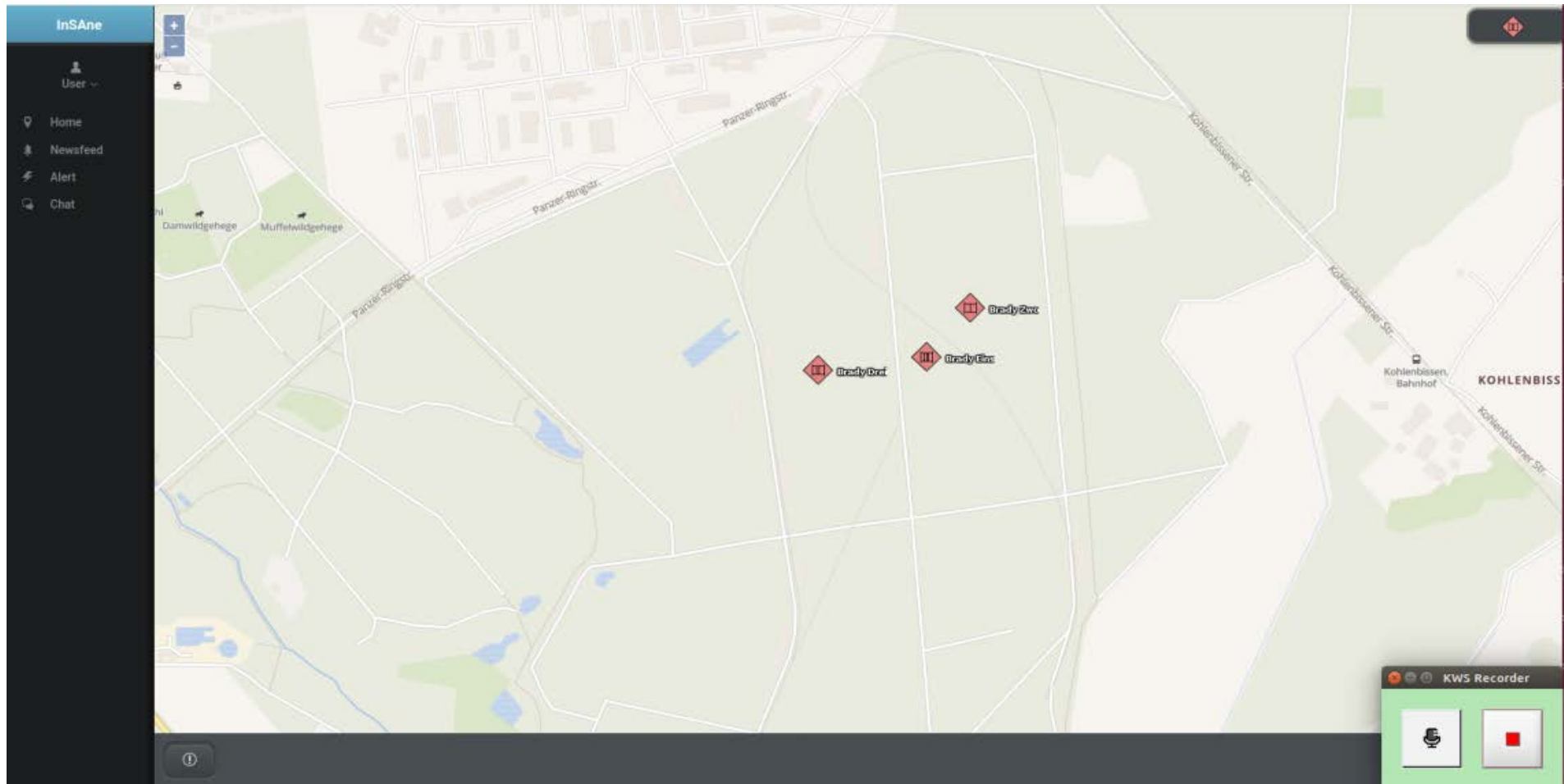
Finite-state dialogue model
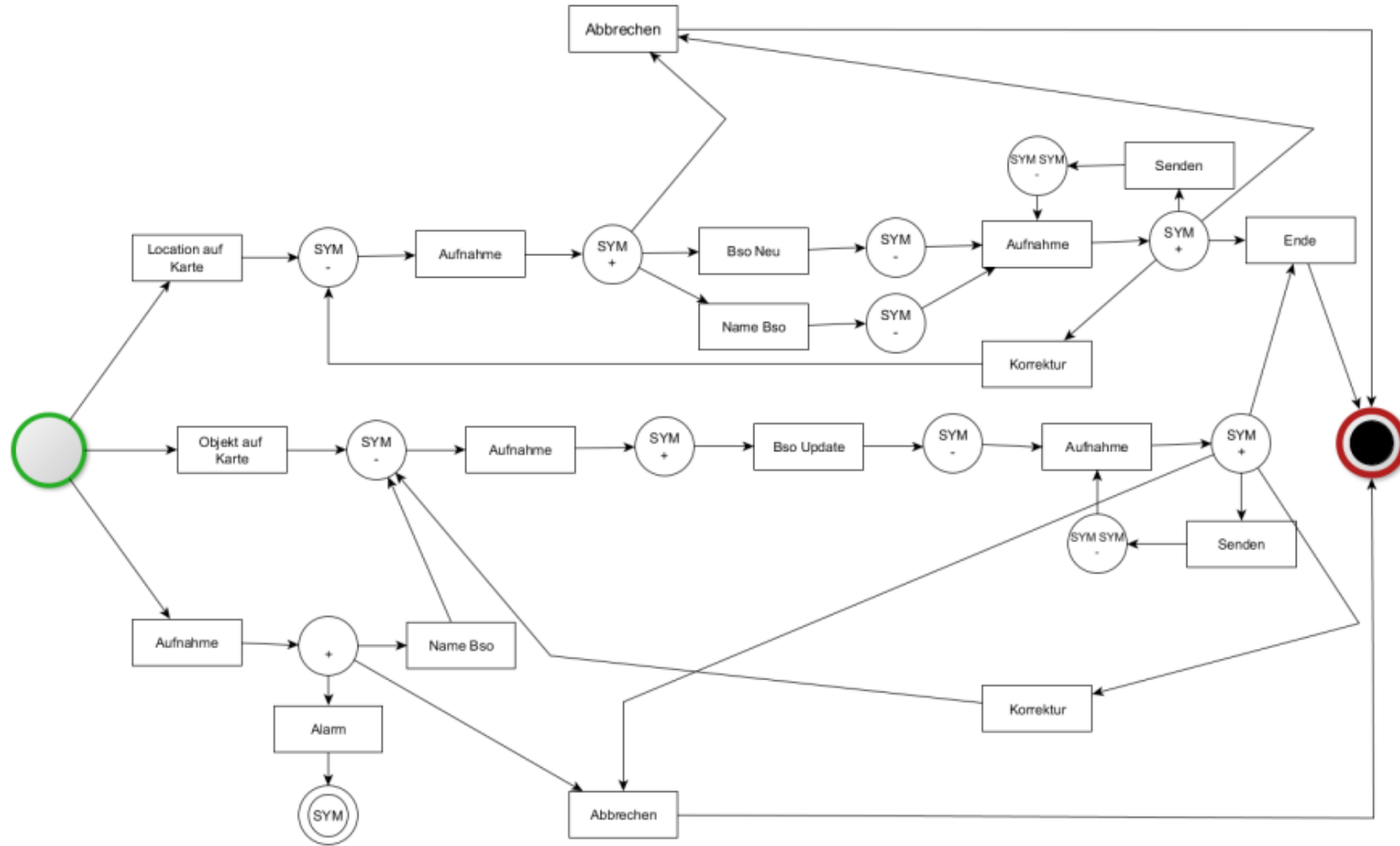
Small-footprint keyword spotting

HFCC-ENS Features

Matching
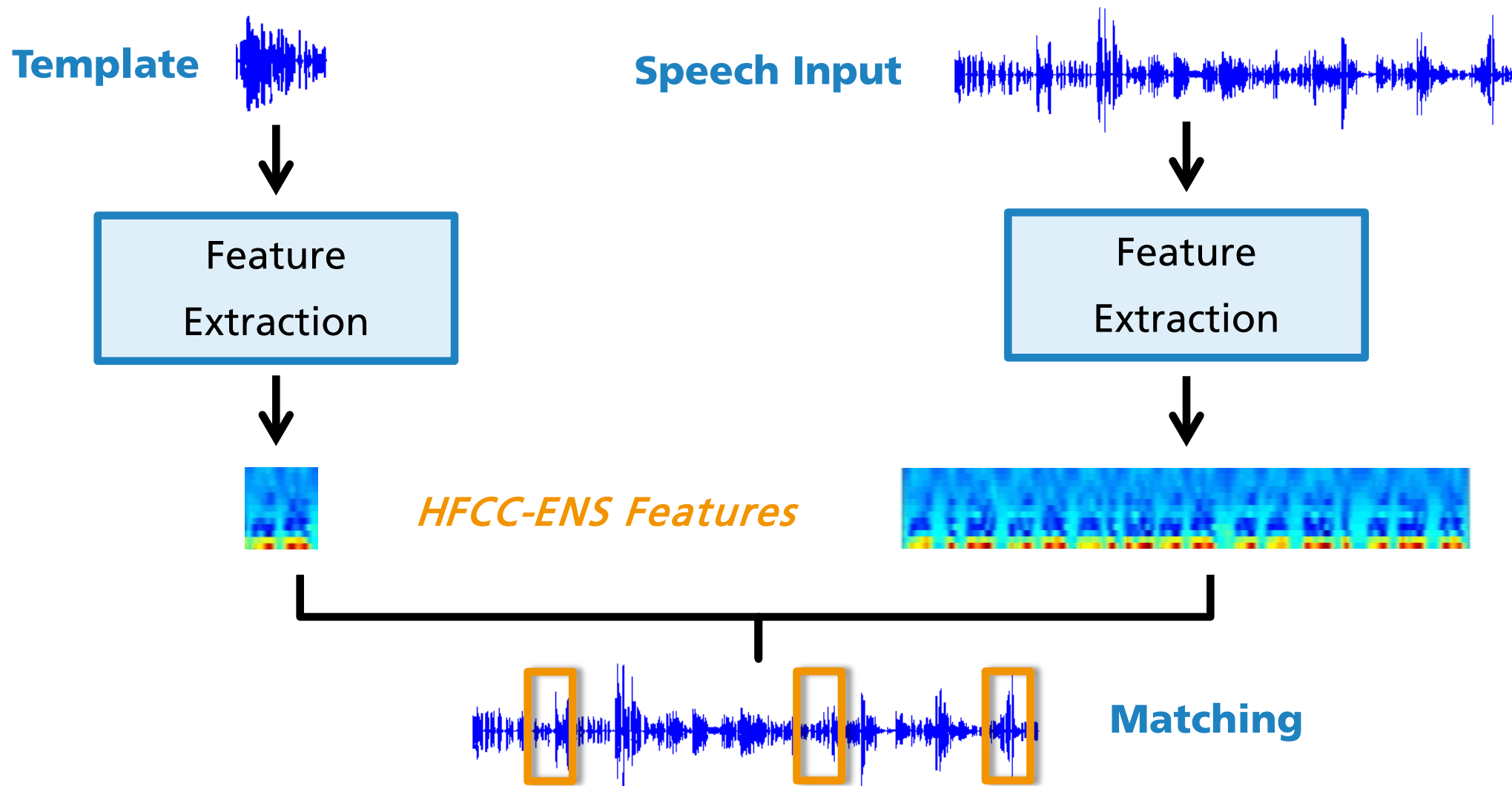
Dynamic Time Warping

Prototype of a (multimodal) Voice User Interface

Evaluation with Operators

Picture removed.

- Don't start with an empty operational picture. Exploit given information and expectations for ASR.

- A local namespace and a naming mechanism are considered very useful. Think about adding more global namespaces (platoon, company). Keep namespaces easy-to-manage.

- Filter feed-back information for various roles. Extend for collaborative system interaction.

- The dialogue model should leave leeway.

- Deployment of a personalized VUI must be quick and simple.

Perceived Usefulness and Ease of Use

- **»The voice control would be useful for me.«**

  Average Rating: 6,25 (3 * 7 + 1 * 5), very clear approval

- **»I could fulfill my tasks better with the voice control.«**

  Average Rating : 6,25 (3 * 7 + 1 * 5), very clear approval

- **»Operating the voice control would be easy.«**

  Average Rating : 6,125 (3 * 7 + 1 * 4), very clear approval

- **»Operating the voice control would be frustrating.«**

  Average Rating : 1,5 (3 * 1 + 1 * 3), disapproval

- **»Operating the voice control would be cumbersome.«**

  Average Rating : 1,75 (2 * 1 + 1* 2 + 1 * 3), disapproval

- **»I would use the voice control.«**

  Average Rating : 6,25 (3 * 7 + 1 * 5), very clear approval

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Conclusions and Outlook

- We implemented and evaluated the prototype of a (multimodal, distributed) VUI to an integrated C2IS.

- Next steps are

    - the definition of additional use cases,

    - the respective extension of the dialogue model,

    - the implementation and evaluation of competing ASR methods (incl an orchestration of several methodologies),

    - the addition of further modalities (transparent displays, gesture recognition, …), and

    - the elaboration of a concept for the personalized training of an ASR system with justifiable effort.

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Thank you.

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