# ICUFL—Tech—LogicalArchitecture

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# 1 Context

'ICU FamilyLink' is a video-call system designed and deployed in the Intensive Care Unit (ICU) at University Hospital Galway (UHG), Ireland. It enables contact between families, patients and the clinical teams providing care. The need for this system arose from visitor restrictions introduced during the COVID-19 pandemic. 'ICU FamilyLink' provides a means to communicate which would ordinarily be available through close family members who would visit the patient at the bedside or attend a family meeting. It provides a secure bi-directional audio-and-video conferencing call or a "virtual visit."

See further details in the press release here.

# 2 Intent

This Logical Architecture document shares general and specific learnings from designing and implementing 'ICU FamilyLink' at UHG – with the intent that this will serve as a technical reference for other teams designing and implementing similar solutions.

Caveats

- 'ICU FamilyLink' was designed and built specifically for the ICU setting in UHG – some of the learnings from this project might be applicable to other care settings, but further studies and pilots should be performed to clarify the applicability in other care settings.
- This document does not provide *clinical* guidance on the usage of video calls in an ICU setting. Rather, it reflects the technical considerations that surfaced, based on clinical feedback, during design and deployment in the ICU in one hospital.

# 3 Outline

This document outlines the logical system flow, interactions and architecture. It also outlines key technical considerations for the system. This document is based on the actual usage flow we implemented but documented in a manner that is agnostic of the primary technology used for the video call system.

The associated documents detail the technology-specific implementation details:

- 'ICUFL--Tech--Core—CiscoWebex': Technical Implementation of the core 'ICU FamilyLink' system using Cisco Webex Meetings and Cisco DX video endpoint devices.
- 'ICUFL--Tech--Client—iPadWebex': Technical Implementation of 'ICU FamilyLink' client training devices using iPads (and Cisco Webex Meetings client software).

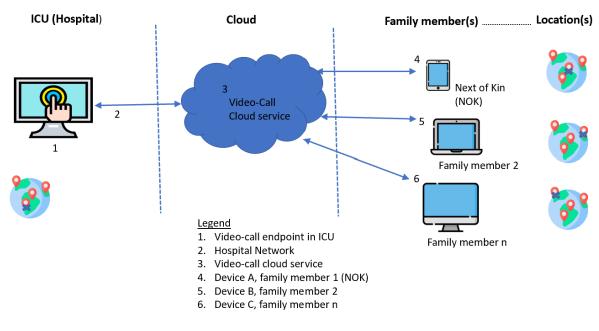# 4  Table of Contents

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# 6   Logical System Flow and Architecture

This section outlines the logical system flow, interactions and architecture. It also outlines key technical considerations for the system. This section is based on the actual user flow we implemented but is documented in a manner that is agnostic of the primary technology used for the video-call system.

## 6.1   Primary Use case

- Video call between the Intensive Care Unit (ICU) and one or more close family members of an ICU patient
- Video initiated and managed by ICU staff
- Ability for clinical staff to arrange and initiate ad hoc virtual visits 24/7 with minimal availability of administration staff.
- The level of participation (of staff and patient) on the ICU side is based on the clinical and professional judgement of the ICU staff.

Note: There are many related use cases that could leverage a similar system. The focus of this document is the primary use case noted above.

## 6.2   Logical System Architecture



Legend
1. Video-call endpoint in ICU
2. Hospital Network
3. Video-call cloud service
4. Device A, family member 1 (NOK)
5. Device B, family member 2
6. Device C, family member n

*Figure 1 : Logical System Architecture*

## 6.3 System Concepts

Each ICU patient area/room covered by the solution is assigned a separate 'virtual conference room' (as a shorthand, let's refer to this as a *'Virtual Family Room'*). Each Virtual Family Room has a specific URL.

Family members who attempt to join a video call will remain in a *'Virtual Waiting Room'* until the staff member leading the call admits them to the video call.

## 6.4 Logical System Flow

**1. Admission**
* Patient admitted to ICU
* Gather Next of Kin (NOK) email address (stored in local admissions system)

**2. NOK emails**
* Send instructions (via email) to NOK:
    i. Part 1 email with video-call system explanation & setup instructions
    ii. Part 2 email with URL link to the appropriate 'Virtual Family Room'

**3. Family setup**
* NOK may forward details to close family members
* NOK/Family members setup & test video-call client software

**4. Agree video-call**
* Phone call to NOK to agree time of meeting (ask them to join 5 mins prior)
* Confirm who will be joining (i.e. NOK + small set of close family members)

**5. 'Virtual Waiting Room'**
* NOK and one/more other family members access the 'Virtual Family Room' URL and are placed in the 'Virtual Waiting Room'

**6. Initiate call**
• Staff member brings the ICU video-call monitor to appropriate area, powers up and selects the corresponding 'Virtual Family Room' from the menu that is presented
• A video call is initiated.

**7. Admit family member(s)**
• Staff member is presented with a listing of the famly member(s) in the 'Virtual Waiting Room' for the specific 'Virtual Family Room'
• Staff member admits and validates each famly member (starting with NOK)

**8. Conduct call**
• Staff lead call, based on local clinical & video-call protocols

**9. Terminate call**
• Staff member terminates the video-call. Video-call is automatically terminated for all family-members.

*Figure 2: Logical System Flow*

The 'driver' at each stage is denoted with these colours:

| |
|---|
| ICU admin staff |
| NOK / Family member |
| Staff member leading the video-call |

Notes:

- This outlines the primary flow that we put in place. In practice, several variations of this flow might also work depending on individual hospital IT infrastructure and availability of staff (clinical and admin)
- Some roles may be interchangeable; for example, ICU staff member may cover 'ICU Admin staff' role, and send the instruction emails.

## 6.5   Technical and Practical Considerations

This section outlines several technical and practical considerations around delivering a video-call system into the ICU setting.

In addressing these considerations for the 'ICU FamilyLink' system at UHG, our approach was guided by the following intent:

- Balance ease –of use with appropriate levels of control and security
- Minimise workload for ICU staff and maximise their sense of comfort with the technology

### 6.5.1   Network

Network access and bandwidth (at the ICU side) is fundamental to a usable and reliable ICU video-call system, irrespective of the video-call technology used (or the video-call endpoints or device types).

It is beyond the scope of the system to control network access (and capacity) at the family-member side of the video call. The considerations and recommendations below relate to optimising the network at the ICU-side of the system.

Key considerations

- Network Bandwidth: Does the network have the bandwidth to handle video calls from the chosen device?
- Network Access: Do you require Ethernet or Wifi access or both for the video-call endpoint (device)?

Recommendations

- Assess
    - Work with the local IT team to understand the local wired and wireless networks in the local ICU setting.
    - Work with the video-call service vendor to gauge the bandwidth required per video call.

- o Resilience: Plan for network access failures; for example, if Ethernet access is preferred for your video-call endpoint, consider also setting up Wifi access on each video-call endpoint, as a fallback mechanism.
- Implement
  - o If wired (Ethernet) connection is required, ensure that suitable Ethernet port(s) are identified per designated area – and that each physical Ethernet port is appropriately enabled, configured for the network, and physically labelled
    - ▪ Consider the physical location of the Ethernet port(s), as this will determine where the Ethernet cable can be placed. The aim is to allow connection of an Ethernet cable (from Ethernet port to video-call device) in a physical location that minimises risk of obstruction or accidents.
    - ▪ Make clearly visible which Ethernet ports can or can't be used for the system. Address this issue with clear labelling of designated ports.
  - o Consider adding extra capacity, if needed; for example, extra Wifi access points or extra bandwidth capacity or both
- Verify
  - Test each network access mechanism, from each physical space that is to be covered by the system.
  - Test the bandwidth available in each designated space (wired and wireless), over a representative set of times.

### 6.5.2   Security

Security is paramount for this video-call system.

The base video-call technology must have a best-in-class security framework and track record. It is beyond the scope of this document to describe the security considerations of the base video-call technology. Rather, some specific security considerations (for the ICU setting) are described.

Key considerations

- Video-call access: Staff control the access of each remote participant to the video–call.
- Video and Audio Controls: Staff can easily control video and audio On/Off and direction of video.
- Ongoing security monitoring and patching of pertinent system components.

Recommendations

- Physical camera lid, and notification when camera is on (for example, camera light on when camera on)
- Physical mute button (clearly labelled)
- Disable all Recording options
- Configure so that when the ICU staff end the video call, the call is automatically ended for all family members

- Plan for ongoing security monitoring and patching of all components, including the video-call endpoint(s), client training/test devices, and base video-call system

### 6.5.3   Sound and Vision Quality

Key considerations

- ICU staff might be wearing Personal Protective Equipment (PPE) – this makes audio and visual communications more difficult.
- Visual: Facial expressions (and other non-verbal communications) are particularly important in this environment.
- Audio: ICU can be a noisy environment (due to ventilators and other equipment).

Recommendations

- Audio capabilities of the video-call endpoint:
  - Strong audio capabilities (speaker and microphone) to be able to maintain high audio quality in noisy ICU environment.
  - Directional noise-cancelling facility to reduce unwanted ambient sounds.
- Visual capabilities of the video-call endpoint:
  - High-quality camera that can clearly convey facial expressions of staff wearing PPE

### 6.5.4   Usability

Key considerations

- ICU staff might be wearing PPE (including gloves) – this makes operating electronic devices more difficult.
- ICU staff have varying levels of technical proficiency.
- ICU staff work in a pressurised, time-critical environment.
- ICU has many existing processes and protocols. It is preferable to tie into existing processes and protocols, rather than create new processes or protocols.

Recommendations

- Video-call endpoint with
  - large screen
  - touchscreen operation
  - large buttons for the main tasks (start or stop the video call).
- Low-touch: Minimise the number of button presses or selections to conduct a video call
- Mount video-call endpoint on a sturdy stand or trolley, or via a secure mounting arm.

- Attach physical labels to the video-call endpoint, to highlight key buttons (for example, Camera, Mute button)
- Configure so that one video-call endpoint covers multiple ICU areas or rooms: This can be accomplished via a simple menu of 'Virtual Family Rooms' provided on the device. A staff member simply selects one to initiate a video call. This also helps to reduce the physical storage space required (for video endpoints).
- Naming scheme: Align with existing local ICU naming scheme for ease of use for staff. Use this naming scheme for menu of 'Virtual Family Rooms' on video-call endpoint, and as part of the 'Virtual Family Room' URL provided to families.

### 6.5.5  Validation

Key considerations

- Validate the system from the ICU side, but also from the 'family' side. The 'family' side should encompass a heterogenous set of devices, network connectivity and technical proficiency of users.

Recommendations

- Ensure that the email instructions to the NOK (and family members) are clear and precise. This will reduce the likelihood of technical issues for family members.

### 6.5.6  Training Staff

Key considerations

- ICU contains a lot of different types of equipment – and ICU staff need to stay 'up-to-date' with that equipment, with many demands on their time. This video-call system introduces another piece of equipment into the ICU setting.
- The video-call system must be intuitive and require minimal training.
- Staff should be adequately trained, and local standard operating procedures should be developed, prior to the system being used with patients and families.

Recommendations

- Provide client devices for training purposes (further detail in section 6.5.6.1):
    o ICU staff can role-play as family members, and experience what the family will see and hear).
    o ICU staff can familiarise themselves with the best place to position the video-call endpoint and where the team should stand, to optimise the video-call experience.
- Provide a training video.
- Print usage instructions and attach them to the video-endpoint stand.

- Train "super users" -- local staff members who can provide continued training and support to all staff.
- Provide scheduled and 'drop-in' hands-on training (because it might be difficult to arrange training time).

### 6.5.6.1 Client Devices for Training

Key considerations

- Ease of use for staff: they can just pick up a client device and easily simulate the 'family member' experience.

Recommendations

- Use a tablet or mobile device.
- Configure the device with links to each 'Virtual Family Room' in your video-call system. A staff member simply selects the link to join the 'Virtual Waiting Room' and then the video call for that 'Virtual Family Room'.
- Lock down the device to the minimum set of application(s) required to serve as a client device.
- Ensure that the device is actively managed; for example, via a Mobile Device Management (MDM) solution.

See the details for one technical implementation in the document 'ICUFL--Tech--Client—iPad Webex'.

## 6.5.7 Notifying Families and Scheduling a video-call

Key considerations

- Prior to any notification being sent, staff should consider whether video calls are appropriate. This is beyond the scope of this document and should be determined by local hospital policies and clinical judgement.
- Identify who is best suited to send instructions to the family (and if applicable to schedule a video call)
  - Each hospital or department may have varying availability of admin staff.
- Determine the method of notification.
  - Recognise existing modes of communication within a department, and integrate into that work flow. (For example, phone call, email notification, patient portal.

Recommendations (This is an approach for hospitals with primarily clinical staff notifying families via the phone and email with minimal availability of admin staff)

- Provide email templates that the ICU staff can easily leverage.

- Integrate the emails into the local IT systems.
- Minimise the requirement for ICU staff to send emails, or other tasks that require 'keyboard time'.
- Minimise disruption to existing workflows; for example, maximise the use of the phone as an enabler to notify the NOK about the proposed video-call.

### 6.5.8 Cleaning/Disinfection

Key considerations

- Video-call endpoint must be cleaned or disinfected regularly according to local guidelines.

Recommendations

- Refer to the (video endpoint) manufacturer's guidelines. Make these instructions easily accessible to ICU staff.

### 6.5.9 Support Family Members with Technical Setup

Key considerations

- ICU staff might not have the time (or technical proficiency, or both) to support family members who experience technical setup challenges with the video-call system.
- Family members will vary in technical ability.

Recommendations

- Provide clear instructions that are suitable for individuals who have limited technical ability.
- Consider setting up a phone Helpline for family members where they can get assistance on technical setup challenges. This 'Helpline' could be listed on the emails (with setup instructions) sent to NOK (and onwards to family members). This 'Helpline' model could provide a level of comfort to ICU staff - that they won't be asked technical questions about video-call setup - and might mean that they are more likely to initiate calls.

# 7 Appendices

## 7.1 Credits

- Icons made by ,Freepik from www.flaticon.com