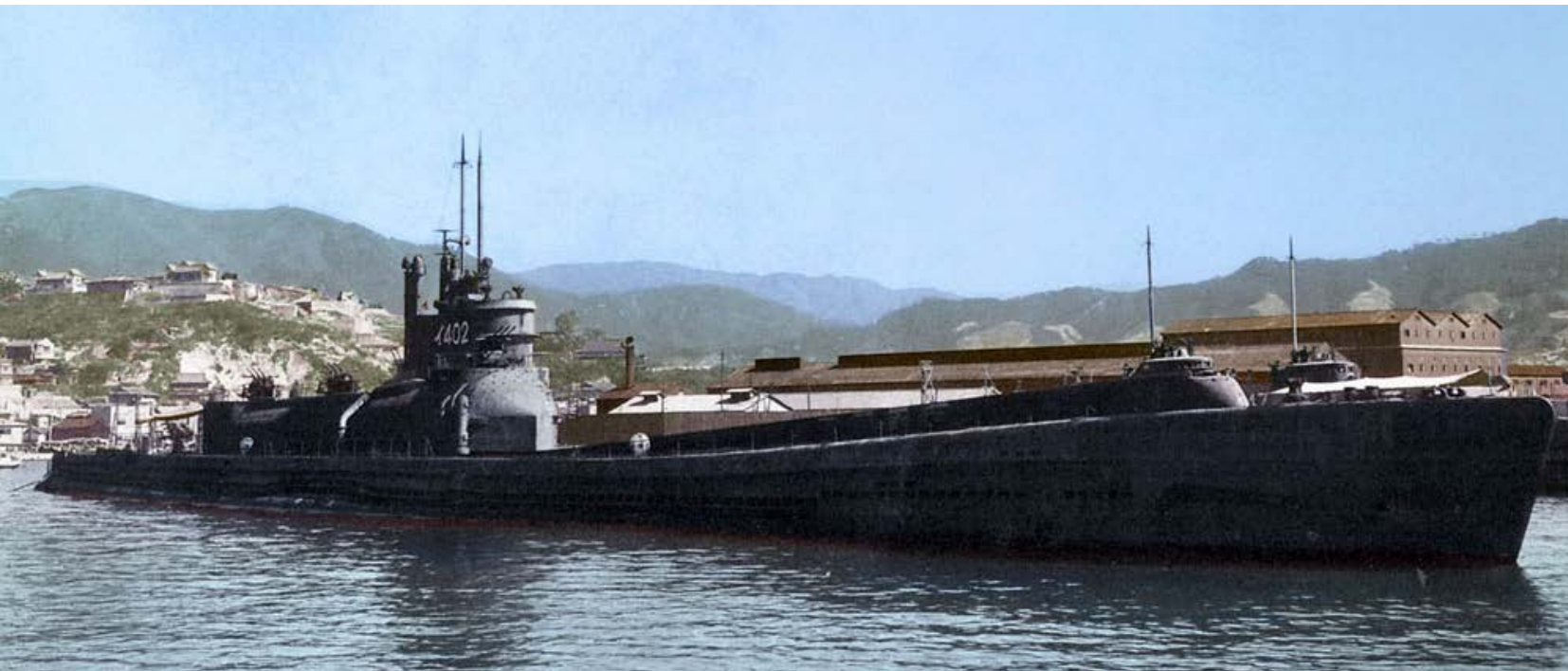


Summary

- Topic: Systems Architecture
- Synopsis: In the midst of WWII, the Japanese secretly began developing a fleet of aircraft-carrying submarines capable of reaching and launching attacks against the US mainland. These vessels constituted the largest subs ever built at the time, and were heavily studied (and subsequently destroyed) by US forces after the war's conclusion. This case study looks at the system architecture utilized by the Japanese Navy to construct such a sub. It also discusses key physical and functional requirements of the system, as well as performance outcomes.

Systems Architecture Example: Japanese WWII I-400 Submarine

Prepared by John Ziadat and Cassandra Degen



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Background

- During the early stage of WWII, Isoroku Yamamoto –Commander in Chief of the Japanese Combined Fleet – set about creating a way to bring the battle to the US mainland
- He conceived of a fleet of aircraft-carrying submarines capable of reaching his enemy's mainland, launching, and then submerging without being detected
- A feasibility test was conducted, and the concept for the Japanese I-400 Class Submarine was born

1



2



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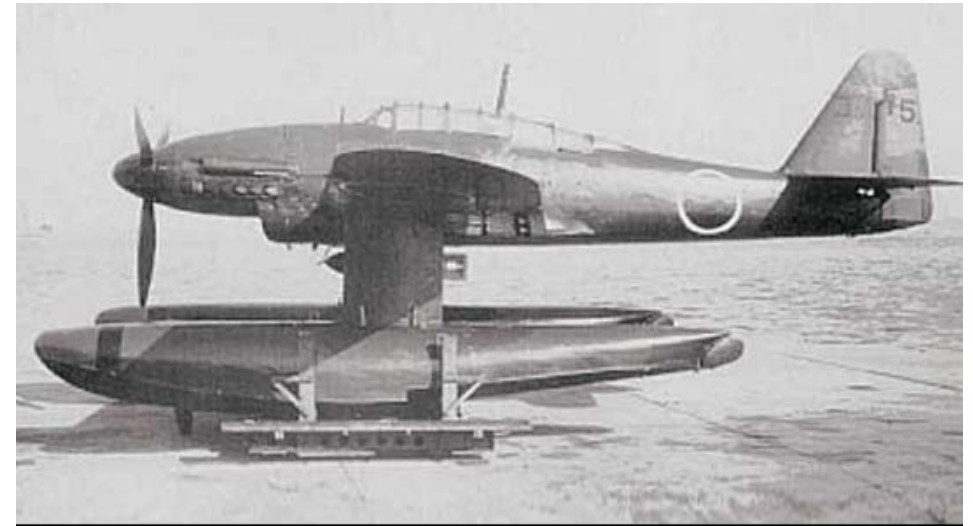


General Isoroku
Yamamoto

Photo Credit:
Wiki Commons

Functional Requirements

- Aircraft Carrying
 - Ability to carry at least 2x Aichi M6 aircraft
 - On-board aircraft would inevitably drive the submarine's size and shape
 - Launching without a runway
 - Moving aircraft from inside sub (storage) to launch position
- Range
 - Capable of traveling to the US mainland and back several times, without having to re-fuel
 - Capable of reaching US mainland from the East or West
- Tactical
 - Dive, launch, descend quickly (stealth)
 - Armed for close-quarter combat

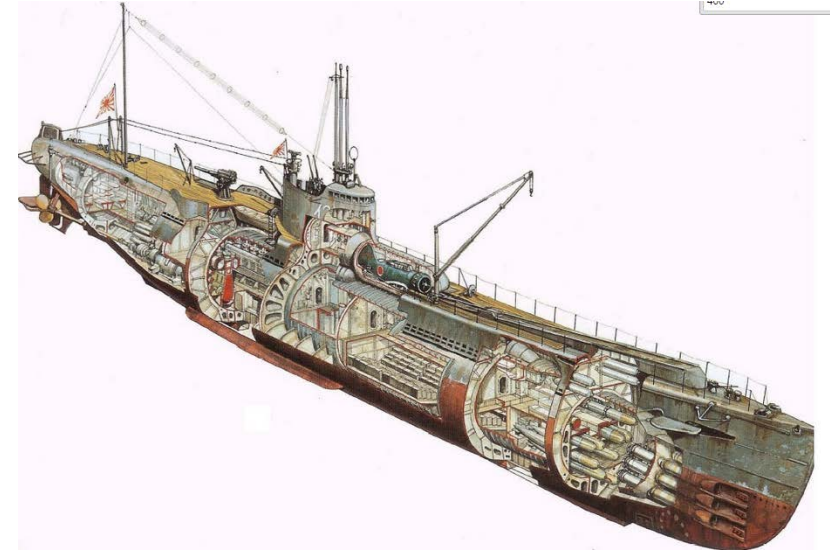


Japanese M6A1 Seiran

Photo Credit: Australian
Warm Memorial

Physical Design Components

- Aircraft Carrying
 - Upgraded during design to hold 3x aircraft
 - Aircraft redesign to fold wings up against fuselage
 - Specialized, “Figure-8” hull design to provide necessary space + structural stability
 - Compressed air catapult on deck for launching
 - On-board collapsible crane for moving/loading aircraft
- Range
 - 4x 2250 HP Engines
 - Enough on-board fuel to propel vessel around the Earth 1.5x

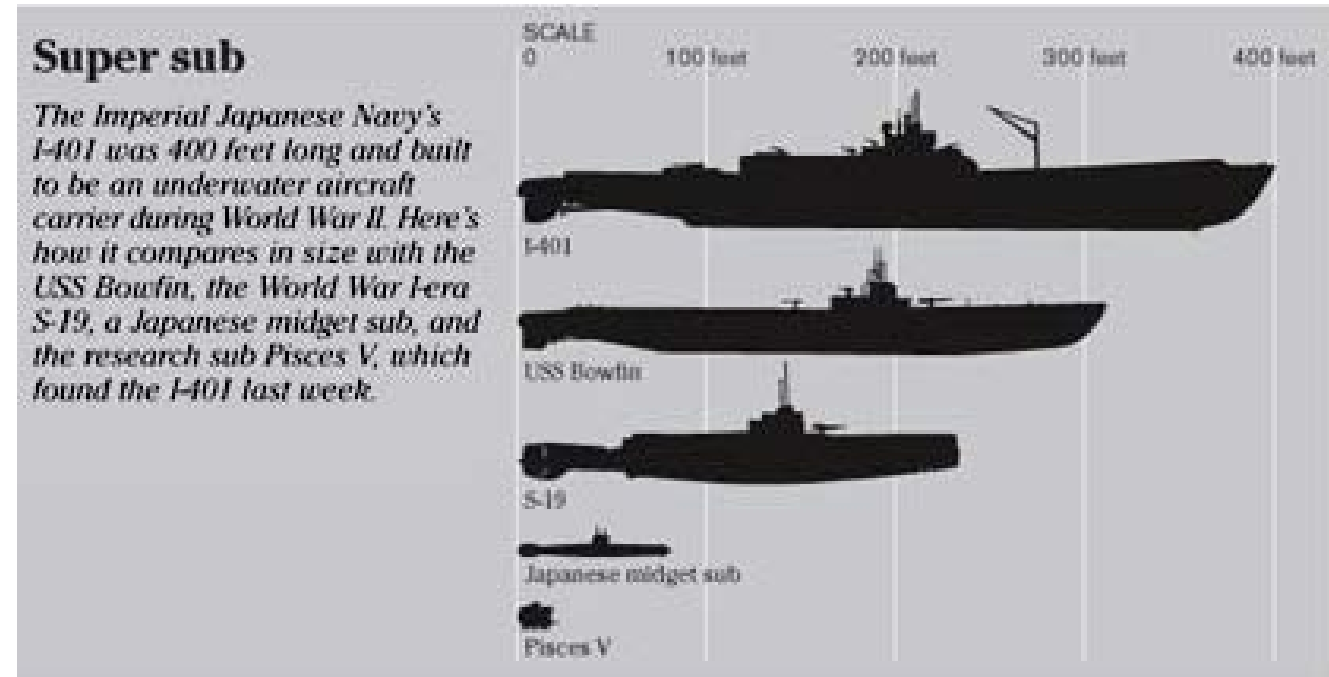


Cutaway View of I-400 Sub

Photo Credit: PBS

Timeline & Size

- Compressed Production Time Line
 - Complete design in ~3 months
 - 1st sub fabricated 3 years after proposal
 - 18 total subs planned
 - Production ramp would be initiated after first prototypes were successful



Comparison of WWII
Vessel Sizes

Photo Credit: Hawaii
Undersea Research Lab

Pictures of Resulting Design

IJN I-400 STO Class (Submarine)

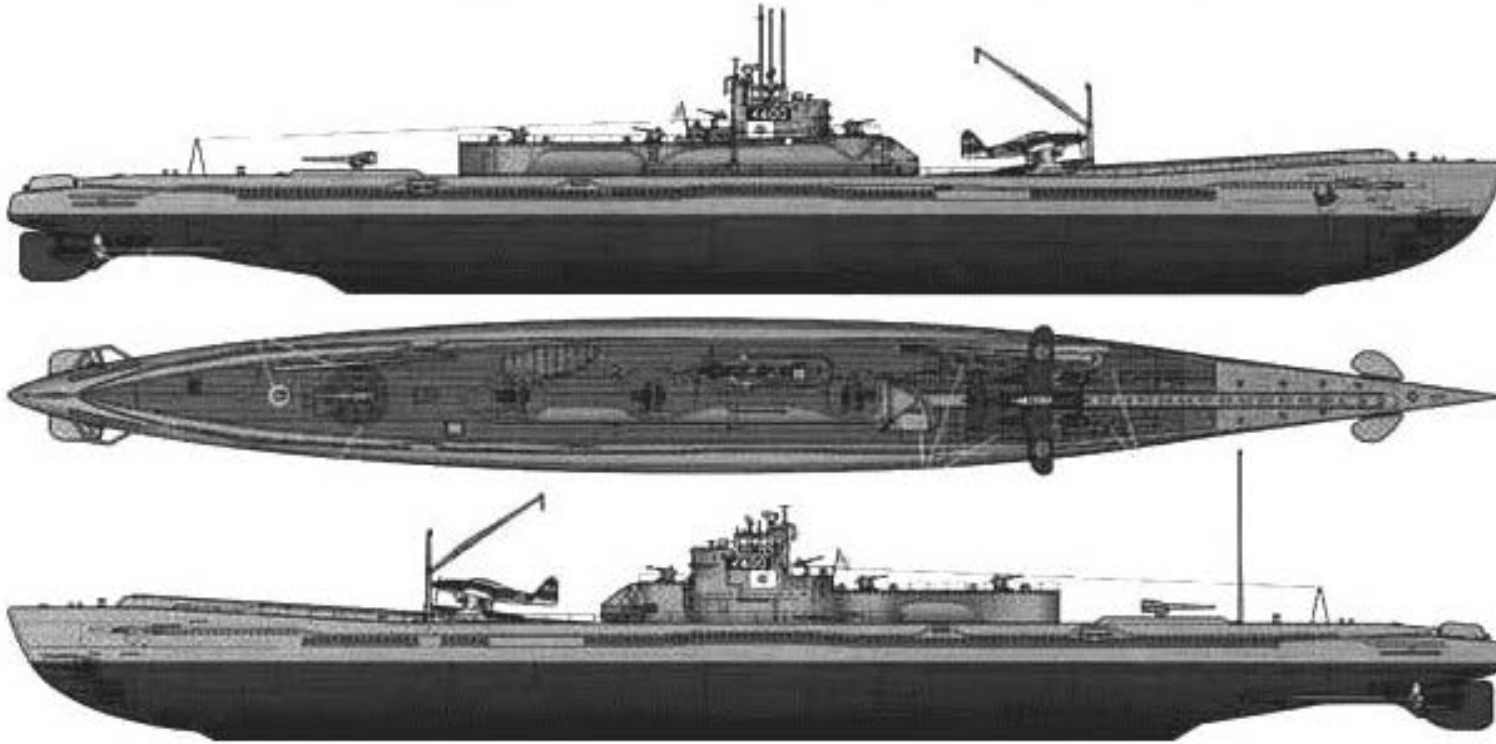
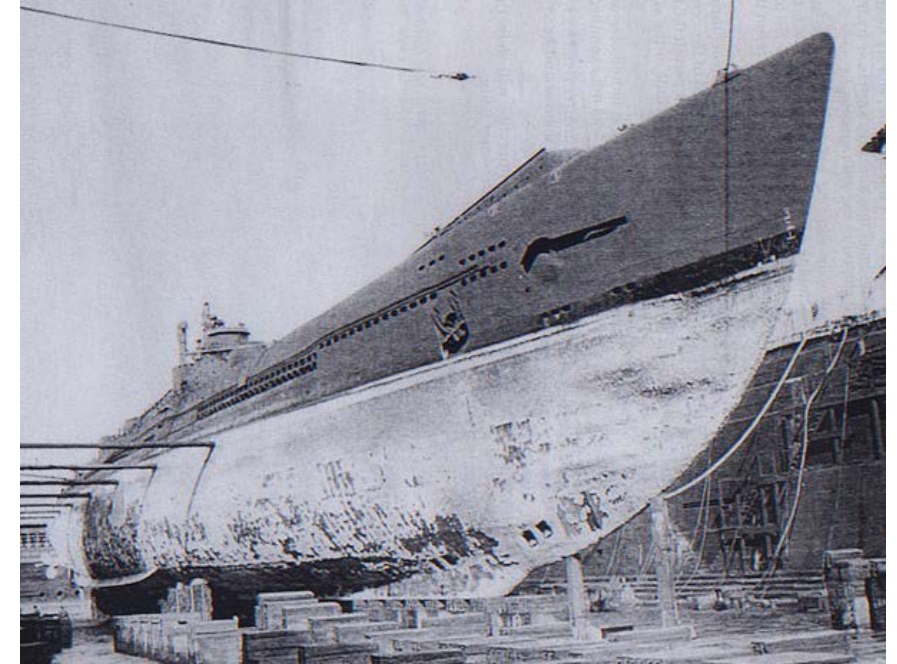


Photo Credit: PBS

Performance Summary & Outcome (1)

- Only 3x of 18x produced
- Underwhelming performance – many flaws stemmed from sheer size
 - Size of rudders relative to sub made for difficult maneuvering, slow cruising speeds (~21mph surfaced, ~14mph submerged)
 - Strong winds/currents acting over large surface area frequently caused vessel to veer off of straight path
 - Safe diving depth was only ~82% of overall vessel length
 - Made for relatively easy detection by overhead aircraft – significant and profound radar signatures
 - Dive time was ~1 minute (double that of the US fleet subs)

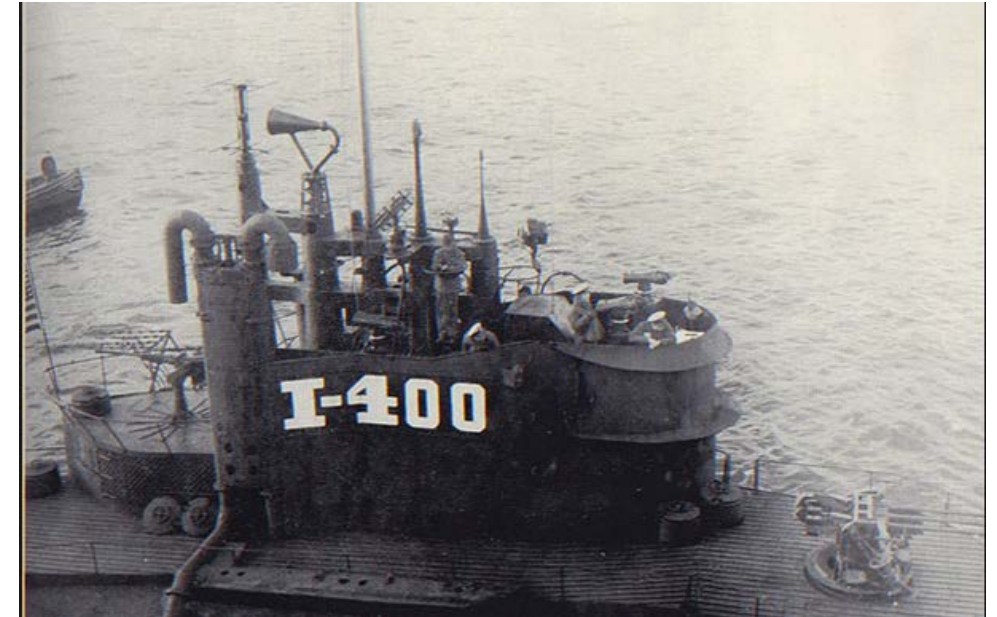


I-400 In Dry-Dock

Photo Credit: PBS

Performance Summary & Outcome (2)

- Proved to be inferior concept for achieving goal of “bringing fight to mainland”
 - US’s focus on advanced weaponry proved to be far more devastating
- Focus on certain features made crew conditions an afterthought
 - No AC
 - No flushing toilets
 - Cramped sleeping quarters
 - Problematic since vessel moved so slowly over such vast distances with large (144-man) crew
- Subs received significant interest from US military personnel after Japanese surrender
 - Ultimately, all 3x I-400’s were destroyed by US forces, in order to prevent Soviet inspection

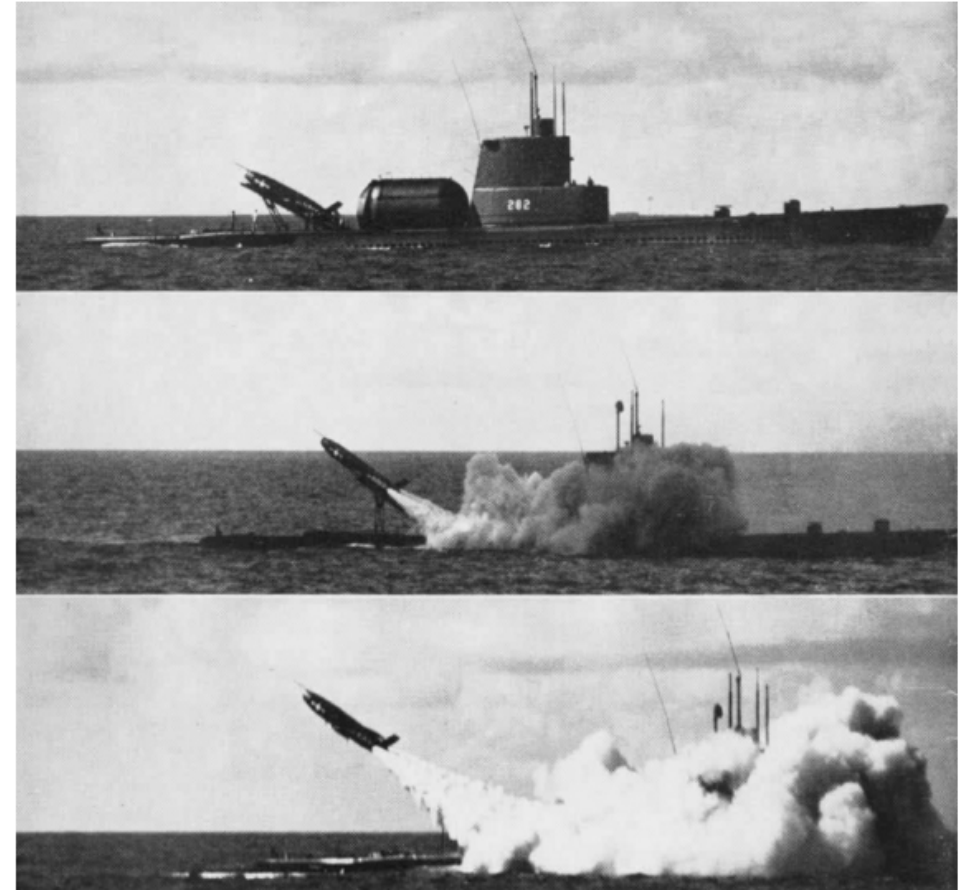


I-400

Photo Credit: PBS

Legacy

- Although the I-400 program didn't bear much fruit, remaining subs were examined in detail by Allied Forces
- As a result of the study of two I-400 subs in Pearl Harbor (post Japan's surrender), the Regulus missile program was born
- The Regulus missile program involved launching nuclear-tipped missiles from a surfaced sub's deck hangar
- In addition, the Douglas Aircraft company designed an attack plane that could be housed in the sub and launched from its missile hangar
- Furthermore, Japan's realization that a submarine could be used to launch an offensive against an enemy city is the basis of present-day sub-based nuclear deterrent systems



Credit: Huff Post

Additional Info

- Sources:
 - https://en.wikipedia.org/wiki/I-400-class_submarine
 - https://en.wikipedia.org/wiki/Submarine_aircraft_carrier
 - <http://www.ww2pacific.com/i-400.html>
 - <http://www.combinedfleet.com/I-400.htm>
- [Watch the Documentary](#)
- Also see: [Ruglus Missile Program Inspired by I-400 Program?](#)
- Note: Photos in this presentation are Hyperlinked

Acknowledgements

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