# JamSpace: Designing A Collaborative Networked Music Space for Novices

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## ABSTRACT

An interactive music environment to support real-time jamming by novices and amateur musicians over a network is described. JamSpace takes advantage of the low latency and connectivity of a local area network (LAN) to allow real-time rhythmic collaboration from isolated locations. Several demonstrated needs that motivate the design are discussed in detail. These include technologically-mediated ways of restoring casual social interactions to the domain of music creation and the preservation of anonymity and privacy for amateur musicians in a group setting. JamSpace's design addresses these needs with a novel hardware and software interface incorporating listening, private rehearsal, mixing, looping tracks and real-time jamming. User-configurable levels of interactivity are analyzed in terms of social spaces.

## Keywords

Collaborative interface, remote jamming, network music, interaction design, novice, media space

## 1. INTRODUCTION

Most would agree that music is an inherently social activity [30], but since the introduction of recording and broadcasting technology, people's musical experiences have become increasingly private. Before these technologies, the only way to hear music was to play it yourself or hear others play it "live", which normally entailed attending a performance with other people. Whether concert music or explicitly social music for dancing, it was an experience to be shared. Broadcasting technology allowed people to listen to distant music in their homes. Soon, recorded music could be produced in an isolated studio, to be heard later in a private setting. Multi-track recording allowed musicians to collaborate on a record without ever meeting or playing together. Eventually, portable music players allowed people to have private music experiences anywhere, even in public places.

Private music listening is not necessarily undesirable, but there is evidence that the social nature of music is reasserting itself, often from a grassroots level, and often using technology. The Walkman existed concurrently with portable stereos (boom-boxes) in the 1980s, and was much less expensive at the time. Yet everyone is familiar with the image from that time of a person playing recorded music in public from a large boom-box perched on his shoulder. Regardless of the societal merits of this practice, it represented a clear desire to share the music listening experience, even in the face of cheaper, less cumbersome personal listening technology. In more recent phenomena such as iPod jacking [33], podcasting and sharing playlists, people have leveraged essentially personal technologies to create a social aspect to music listening. These examples imply that while our concept of music may be changing, it possesses some fundamental properties that compel us to share musical experiences.

Until quite recently, however, there have been relatively few examples of technologies designed with the deliberate aim of fostering social musical experiences. Karaoke is probably the most notable historical example. Whether in its sing-along or more intimate karaoke-box form, it brings together groups of people to "create" and listen to music, drawing on a shared knowledge of the popular music repertoire. Even karaoke itself was not designed top-down – it appears to have grown somewhat organically as a technological enhancement of a Japanese tradition of amateur music performance at social gatherings [34].

Just as technologies have been leveraged to create new social modalities for listening to music, they also have the opportunity to reintroduce casual social contexts for *making* music. Emerging technologies are beginning to address needs for technologically-mediated interactive social experiences, musical [6, 27] or otherwise [13], now by design.

The initial motivation for JamSpace was to create a distributed music application for a large local area network (LAN), to be used by amateur or novice musicians for recreation. There are a number of precedent application for music over networks, but most are either created by performers for their own use, or are designed for experienced musicians [1].

The technology of a large LAN, as in a hotel, office building or university campus provides two important features that are leveraged in the design of JamSpace in order to suit novice musicians. These are 1) low latency, and 2) connectivity in isolated locations. The design of JamSpace makes use of these features to offer constrained, real-time rhythmic performance with a user interface that maintains privacy and anonymity. The rationale is that privacy and anonymity allow users to engage the interface at their own pace, without inhibition or intimidation. Furthermore, individual users are given control over the level of interactivity. A metaphor of a flexible, configurable space is developed below to illustrate this idea.


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**Table 1: Networked Music Systems**

| System | Locations | Time | Sound |
|---|---|---|---|
| FMOL [20] | WWW | RT | SW synth |
| Jammin' on the Web [9] | WWW (remote) | Non-RT | SW synth |
| NetJam [21] | E-mail | Non-RT | MIDI Synth |
| Network-centric music perf [17] | LAN (local) | RT | Audio |
| NINJAM [25] | Internet (remote) | Synced Non-RT | Audio |
| Public Sound Objects [2] | WWW (remote) | Near-RT | SW Synth |
| SoundWIRE (Jamming) [28] | Internet2 (remote) | RT | Audio |

# 2. CONTEXTS

As an interdisciplinary endeavour, the design of a novel music interface should be situated in terms of relevant contexts in a number of different fields. The design of a collaborative networked music application for novices in the contexts of network music, media spaces and online virtual environments is discussed below.

## 2.1 Network Music

Networks have been used for making music for some time. Network music systems can be categorized in terms of the locations of the of the performers (local vs. remote), the temporal quality of the interaction (real-time vs. non-real-time), and the nature of the sonic material (audio vs. synthesis). Selected network music systems are summarized in terms of these criteria in Table 1.

### *2.1.1 Location*

Due to bandwidth constraints, most early network music systems used LANs, where data or audio were shared in real-time [4, 16]. LAN applications tend toward customized avant-garde performance systems. While LANs can span buildings or small areas, LAN music systems generally preserve the face-to-face nature of traditional music performance, focusing on new ways for performers to collaboratively synthesize and process sound in real-time. The inherent latency and bandwidth constraints of the Internet limit the degree to which these can simulate same-room interactions, but distributed applications can potentially include large numbers of users and provide radically new modes of interaction [20, 31].

### *2.1.2 Time*

Data transit times of different networks are continuously variable, making it difficult to define a precise boundary between real-time and non-real-time. For the purposes of this discussion, real-time is defined as a best-effort attempt to have a local control cause an immediate response on a remote computer. Real-time systems therefore strive to appear synchronous from the users' perspectives, although this is not always achieved. Average transit times on a LAN are typically around 1 ms [12], and are at least one or two orders of magnitude longer on the Internet or other dedicated long-distance networks, depending on the distances involved. Synchronous real-time performance over Internet is a challenge do that particular network's inherent limitations.

The temporal characteristics of a network have profound influence on the interactions it can support. Tanaka [31] likens this idea to the intrinsic connection between musical genres and the environments in which their performance practice developed. One would not play bebop in a reverberant cathedral, for example. In fact, bebop would probably not have developed as it did if Charlie Parker had not been playing in jazz clubs. Network music systems may account for the temporal characteristics of the network in their sound design – using a slowly-varying synthesis algorithm for example, so that the effects of latency are less pronounced [20]. Some even exploit network delay as an integral part of their operation [11, 24, 29].

### *2.1.3 Sonic Material*

Until recently, real-time processing and delivery of high-fidelity audio were limited by computing power and network bandwidth. Most early efforts therefore used synthesized sound that could be rendered locally on each machine or on a separate synthesizer [4, 21]. The network then only had to transmit much more compact control information, usually in the form of MIDI. Among the humblest systems was NetJam, which allowed users to edit MIDI files by email [21]. A now-defunct system known as ResRocket claimed to allow users to jam in real-time via the Internet using MIDI, though they had to cope with long and unstable delays inherent to the Internet.

Systems using audio either make use of the high bandwidth and low latency of a LAN [17] or dedicated research network [28] in order to facilitate real-time interaction, or else use non-real-time (or "fake-time") technology [25]. While it does not allow jamming with live instruments, synthesized sound has the advantage of engaging users who do not have musical instruments. Furthermore, it allows a deeper level of interaction design, where the sonic content and available controls can be appropriately designed for the spatial and temporal characteristics, as well as the users of the system. This can foster novel interactions, as in [1, 20, 29].

## 2.2 Media Spaces and Online Games

Media spaces typically consist of isolated locations linked by audio and video connections in order to create the metaphor of a seamless physical space for the purpose of collaborative work. Gaver [14] arrives at a similar conclusion to Tanaka with respect to media spaces, recognizing that virtual spaces do not support the same kinds of interactions as the real world, in spite of the metaphor. This is strongly related to the theory of affordances, which in psychology describes the relationship between properties of a system and the actions that can be taken on it [15]. Extended to the fields of HCI and design, affordances become the actions or rather the "perceived actions" that can take place by a user on an interface or object [26].

In spite of the recognition that technologies can create new modes of interaction, media spaces and many online virtual environments don't try to create new paradigms. For the most part, these try to imitate face-to-face interactions in a virtual world. This has led to criticism in the literature that network-based interactions are "unnatural" or inherently inferior to face-to-face interactions [23]. Many are indeed unsatisfying, but this is most often attributable to the fact that these systems have not exploited the unique possibilities and opportunities of the their underlying technologies. There still exists a preoccupation with simulating real life; creating experiences that are "just like being there", when in fact we could be creating experiences that are entirely not otherwise possi-

ble when we are in the same room.

There are many unique features that networks can offer. In many cultures there appears to be a tendency toward inhibition and intimidation with respect to novice or amateur musicians. This can result in an unwillingness for novices or amateurs to engage in public or shared music-making experiences. There is an opportunity for technology network technology to break from the real-world and offer an empowering experience to those who would not otherwise participate in making music.

# 3. INTERACTION DESIGN

JamSpace's hardware and software components are described and illustrated below. The interaction design is analyzed according to Blaine and Fels's contexts for collaborative interfaces [5], and in terms of spatial metaphors.

## 3.1 Hardware

Each JamSpace terminal has a JamPads hardware interface consisting of a flat surface with 12 raised pressure-sensitive pads. The pads can be pressed or struck with the user's hand, triggering a note with loudness proportional to force. The pads are mapped to percussion instruments or to the notes of the musical scale, depending on the instrument selected by the user. An LED below each translucent pad is illuminated when the pad is struck. Any track in the JamSpace or another players real-time jam can be assigned to the LED display on the pads, helping the user to visually and aurally learn other parts. Novices can learn to play along, the first step in creating, in very little time.

## 3.2 Software

The JamSpace software consists of a client GUI application and a separate server application. The client GUI consists of 5 components: a scratch track for the local user, a set of tracks from the JamSpace, an interface for making connections to the server, tempo and metronome settings, and a matrix for managing real-time jams with other clients.

### 3.2.1 Tracks

Users have one scratch track, into which they can privately record and play back one phrase. A drop-down box allows the user to select a synth instrument (currently using general-MIDI instruments, parametric software synthesis may be added in a future version). For tracks in the JamSpace, this box is replaced by a label. A user may choose to submit her scratch track to the JamSpace. Tracks in the JamSpace have a duration of one phrase, and loop until they expire after a period of time, but may be renewed through a voting mechanism. A server queue manages the finite number of active tracks in the JamSpace. Whenever there are less than 4 tracks in the jam, computer-generated tracks are added. Track data is displayed on a timeline interface.

### 3.2.2 Tempo

A global tempo is maintained by periodic sync messages from the server. 8 beats make up a phrase, and there is a cycle of 4 phrases. Each user can activate any of 3 click tracks which tick at the phrase, beat, and half-beat time scales. Any user can request a tempo change by typing a new tempo in the box. Changes in tempo are also managed by voting.

### 3.2.3 Real-Time Jamming

Users can jam to their custom looping track mixes or with other live users in the JamSpace. Users may also broadcast their jams, in which case all other users can choose to listen to them in real-time. The low-latency of the LAN and compactness of synth control data transmitted between jammers assures that jams appear to be synchronous to the users.

Users choose an icon from a pre-defined list to represent themselves in the jam. A unique icon appears beside all tracks that a user has submitted to the JamSpace, as well as beside her place in the connection matrix. This affords direct musical communication and development of taste, style and identity, while protecting privacy and anonymity.

## 3.3 Contexts of Collaborative Interfaces

Existing networked music systems typically target experienced musicians. Interfaces for novices do exist [2, 8], but these are the exception, as the designers of such systems tend to be musicians themselves. Blaine and Fels [5] point out a similar trend in the NIME field as a whole, particularly with respect to music controllers. They acknowledge a tradeoff between the inherent expressivity of an interface and its complexity, which demands a non-trivial balancing on the part of the designer. In a sense, this is the challenge of any interaction designer, but it is significantly complicated by the fact that in music, the task, and therefore the evaluation of a user's ability to perform that task, are often not clearly defined. Framing this as a tradeoff implicitly renders Wessel and Wright's ideal of "low entry fee with no ceiling on virtuosity" fundamentally paradoxical [32].

Blaine and Fels analyze a number of collaborative music systems in terms of 'constraint' over a variety of design elements of the interfaces, where highly constrained interfaces are generally instantly accessible but provide little room for innovation. They argue that the duration and location of engagement of a collaborative music interface by a user can partly dictate the level of constraint necessary to provide a satisfying experience. Group interfaces for novices situated in public places often engage users for short periods of time and must therefore provide a minimal learning time – the ability to "walk up and play" that a novice almost never gets from a traditional instrument.

For the purposes of trying to maintain a general framework for evaluating collaborative interfaces, I discuss JamSpace with respect to several of the design elements described by Blaine and Fels. Some of these elements are obvious or have been discussed above, therefore what follows does not exhaustively cover Blaine and Fels's list.

**Focus** distinguishes a performance interface for the benefit of an audience versus a recreational experience for the benefit of the players. While JamSpace is intended to include at least one station in a public location that could support a casual audience, the primary focus is for the enjoyment of the players.

The **scale** of the JamSpace presently allows up to 14 simultaneous users. However, the configurable modes of **player interaction** ensure that each user's experience is unique. Each user can choose her own mix of available tracks, and monitor any number of the broadcasting jammers in real-time. While each user possesses the same interface, the experience and contribution of each is unique.

JamSpace does not explicitly employ **directed interactions**, but the interface does allow users to indirectly learn from each other. Flexible modes of interactivity al-

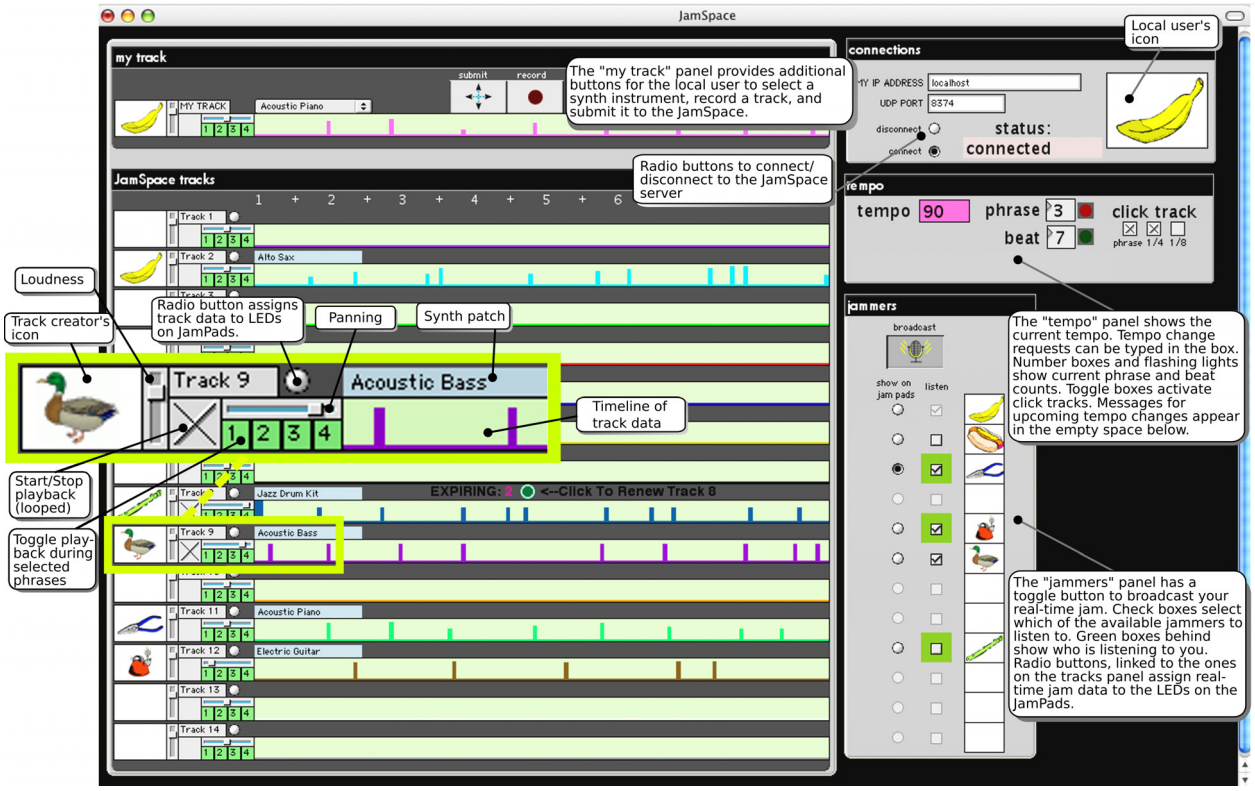


**Figure 1: JamSpace client GUI**

low users to see what another person is playing in real-time, or the contents of a looping track. By assigning any of these sources to LEDs embedded in the hardware control pads, a user can see what another is playing, directly on her own interface. By disabling broadcast mode, the user can privately play along, develop her own variations, and record them to a track or broadcast to the JamSpace at her own pace.

Blaine and Fels do not consider the particular case of networked collaborative interfaces in detail, and therefore there are unique constraints that apply to JamSpace with respect to several of their design aspects. Of particular importance are the **pathway to expert performance** and **learning curve**. Blaine and Fels argue that a "low entry fee" is paramount, and thus the ideal of "no ceiling on virtuosity" must be tempered. This is mostly due to the pattern of engagement of publicly-situated collaborative interfaces, where users do not have the time to even feel the need to achieve virtuosity, let alone the time to develop it. In order to provide enough rapid satisfaction to ensure further engagement, the public interface must also have a fast learning curve. A privately-situated interface such as the JamSpace is quite different. Users do not have infinite time, but may explore the interface at their own pace, without any public pressure. They are more likely to have the opportunity to return to the interface after some amount of time. This excuses a moderately slower learning time, as self-paced exploration and discovery are part of the design. Looser control over the **musical range** of the material is therefore also warranted, so that users may remain satisfied and develop proficiency over time. JamSpace allows a set of chromatic notes in a constrained octave and free rhythms within the circumscribed metric structure. The interface is simple enough that an amateur musician with a basic knowledge of notes and rhythm can produce meaningful material. Novices can easily grasp and expand on this material or that of computer-generated tracks.

## 3.4 Spaces

The levels of interactivity within the JamSpace can be analyzed in terms of a spatial metaphor. The different modes of interactivity can be seen to reflect different spaces. In some ways, it also demonstrates characteristics of different spaces at the same time. There is a strong tradition of discussing systems for computer-supported collaborative work (CSCW) and virtual environment in terms of real-world spaces. Jeffrey [19] demonstrates the applicability of the psychological concepts of personal space, group space and privacy in virtual environments. The following discussion pertains to JamSpace stations located in isolated locations.

### *3.4.1 Private Space*

Private spaces imply physical barriers that can exclude all but one person. Privacy has different meanings in different contexts. With respect to technology, it is synonymous with security and confidentiality. In psychology, it normally refers to isolation or solitude [7]. In both senses, JamSpace can represent a private space when the user is not connected to the JamSpace server. In this mode, the user is invisible to all others, and may play on his or her own JamPads, and record, play back and play along with one track. The user's identity and presence are invisible to the world, and he or she is assured of an environment that may not be intruded.

### *3.4.2 Personal Space*

Personal space is an individually-variable, context-de-

pendent concept in social psychology that refers to a preferred boundary zone around a person [22]. Distinct from but related to privacy, the boundaries of personal space are transparent - when you are in public, anyone can see you within your own personal space, and others are clearly visible to you. The aim of JamSpace is not to explicitly capture this concept in a collaborative music environment. Rather, it employs a level of interaction wherein the user is aware of the presence of others and vice versa, but they do not interact and therefore do not share space. In connecting to the JamSpace, other connected users become aware of the user's presence, and he or she becomes aware of them. The user may perceive the rest of the world - he or she receives tracks and can listen to other jammers, but cannot actively participate with them until progressing to a further level of interactivity.

### 3.4.3 Shared Space

Shared spaces are occupied by groups of people. Like personal space, they may exist with transparent borders within a public space. As CSCW began to flourish in the late 1980's, the notion of creating virtual shared spaces or "media spaces" [14] for collaborative tasks became the standard paradigm for remote collaborative work. Benford [3] analyzes spatial approaches to collaborative work according to the criteria of transportation, spatiality and artificiality. Implicit in this analysis is that space is not just a metaphor in these systems, there is a deliberate attempt to produce or reproduce a 3-dimensional space complete with representations of its human occupants. Buxton [10] distinguishes between shared *person* and *task* spaces, where the former refers to an overall sense of copresence and mutual awareness, while the latter is constrained to the domain of a task. Task spaces do not necessarily include the assumption of explicit spatial representations. Harrison and Dourish [18] challenge the pervasiveness of spatial metaphors, arguing that many CSCW systems more closely embody a concept of *place* than they do *space*, and therefore offer a different set of affordances. Breaking the spatial metaphor carries with it the opportunity for conceiving interactions that are not possible in real spaces, but may be otherwise desirable.

In that there are no graphical or explicit spatial representations of the users in the JamSpace, therefore the spatial metaphor is a weak one. The notion of a collaborative task space is more appropriate. By broadcasting a real-time jam and/or submitting tracks to the JamSpace, users can actively share the JamSpace with others. Users can see who else is listening to them, and may choose to listen in turn and engage in jamming. Submitted tracks form an integral part of the jam, to which users collaboratively contribute.

There is a slight distinction between this metaphor and the traditional definition of shared space, particularly with respect to membership and invitation. In social psychology, group membership carries strong consequences, and complex social mechanisms govern membership and belonging. In the JamSpace, there are no explicit ways of communicating invitation or perceiving membership. Anyone with a JamSpace terminal may join at any time, and users don't know the identities of group members, nor can they monitor all of the members' actions. This breakdown of the strict metaphor of social spaces is not seen as a limitation in the design, however. Rather, JamSpace drawing on aspects of different types of spatial interactions in a beneficial way. Real-world privacy and personal space

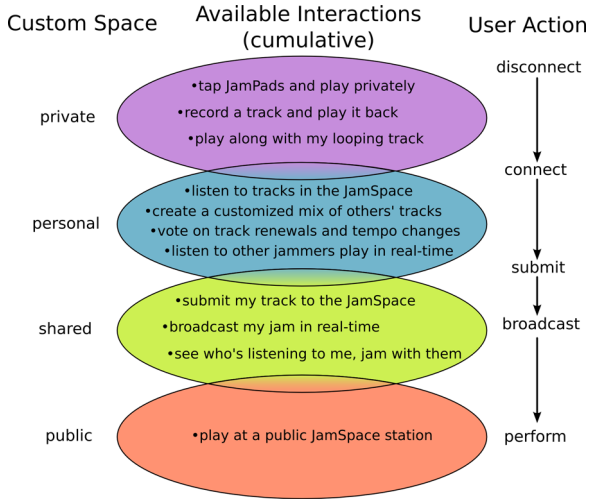


**Figure 2: User-configurable space metaphor**

are maintained while group interactions are possible.

### 3.4.4 Public Space

People are mostly free to see and do what they wish in public spaces, within a set of social and cultural norms. They are venues for self-expression and places where people may gather. The design of public spaces must balance the needs for freedom and expression, with those of common decency and protection from offence. In simultaneously embodying the characters of multiple spaces JamSpace assures these ideals partly by the same mechanisms that it ensures privacy. Constraint over the sonic material, and protection of identity ensures that no direct communication between users is possible. Unlike real public spaces, the only possible offence or intimidation that could be perpetrated would be not listening to another person's jam. However, the ideal of expression is maintained. In broadcasting and submitting tracks, a user airs his or her expression in front of all other JamSpace users, regardless of whether they are listening.

JamSpace stations in real public places elevate expression to a different level, providing a venue for the local performer publicly demonstrate his or her musical skills or self-expression in a real-world space. Of course, real-world social conventions and limitations apply here, and the user is subject to the ensuing rewards as well as consequences.

## 4. CONCLUSIONS

With respect to JamSpace, the spatial metaphor is really just a metaphor. In many CSCW systems, the design seeks to emulate or simulate real spaces and the kinds of interactions that they support. For JamSpace, a spatial metaphor is a useful conceptual way of characterizing the interactivity, but the system does make explicit representations of spaces. Instead, it leverages the characteristics of its technology, users and scenario to create new modes of musical interaction.

The overall design philosophy of JamSpace was to begin with a specific technological platform (local network) and application area (recreational music), and then leverage their affordances to find novel interactions that address the requirements of the scenario. JamSpace is a work in progress. The system is currently being deployed for eval-

uation with two actual hardware interfaces, along with a number of others using a software emulation of the hardware. Initial impressions show the system to be engaging for both novices and experienced musicians. A systematic evaluation is forthcoming.

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